EDITORIAL

DURING November the American Mining Congress will be held at the Hotel La Salle, Chicago. Considerable attention will be devoted to the oil industry as well.

PLANS for bridge and tunnel crossings of San Francisco bay have been forwarded to the War Department Engineers at Washington. In this issue we present a proposed solution of the problem by Mr. H. Devereux. Mr. Devereux considers both the engineering and the financial features of the problem, and suggests methods not only for financing the bridge construction itself, but also the preliminary surveys that are necessary before the project takes definite shape. In this connection, it should be noted that since that part of the issue went to press, Mr. Devereux has decided to apply for copyright upon his article and plans.

GENERAL Orders No. 32 of the War Department, relating to the Officers' Reserve Corps, have recently been issued and may be obtained from the United States Army Headquarters, Western Department, 216 Pine street, San Francisco. A summary of the part relative to the Engineer Corps has already been distributed to members of the National engineering societies. However, a study of the original document will show that engineers are particularly fitted for service in several other branches of the Army as well as the Engineer Corps, namely, the Coast Artillery, Field Artillery, Signal Corps, Quartermaster Corps, and Ordnance Department.

TWO important legal decisions affecting the status of withdrawn oil lands have been rendered during the past month. At St. Paul, the United States Circuit Court has upheld the validity of the claims of the Ohio Oil Company to certain withdrawn lands in Wyoming. In this case, the company was not actually at work on the land on the date that it was withdrawn, but material for drilling had been ordered and was on the way. Should this reasonable ruling be sustained it will materially assist several California companies that are now being sued by the Federal Government. The other decision was in the case of the Devil's Den Consolidated Oil Company and Lost Hills Mining Company, where Judge Robert S. Bean ruled that the fact that application had been made before the Land Office for patents to the property in question and receipt for money issued did not prevent the Government from bringing suit against the defendant companies. The Court therefore ruled that it had jurisdiction in the case and that a receiver should be appointed for the property.

SEVERAL months ago we commented upon the removal by the Board of Public Works of San Francisco of the structural engineer for the department of building permits, without cause and in spite of the opposition of the leading structural engineers of the city. Apparently this sort of procedure is contagious, for Mr. Walter N. Frickstad, assistant city engineer of Oakland, has recently been removed from his position by the city council. This was in the face of protests from a number of engineers, including Mr. Perry F. Brown, city engineer of Oakland, who stated that Mr. Frickstad's work was entirely satisfactory. Without discussing the charge that Mr. Frickstad's dismissal was caused by the fact that he had performed his duties as inspector of street-pavement construction too conscientiously, it is submitted that the whole affair is not going to attract men of high integrity and technical ability to the service of the city of Oakland.

ELECTION DAY will come soon after this issue is in the hands of our readers. One important engineering question is to come before the voters of California, namely, the $15,000,000 bond issue for the completion of the State highway system. It is to be hoped that the advocates of highway improvement will not become so confident of success as to relax their efforts in behalf of the bonds. It is true that there is no open organized opposition anywhere in the State, while newspapers and societies of all kinds are enthusiastic in their support of the measure. Nevertheless, it should be remembered that large bond issues, even for meritorious projects, are unpopular at the present time, as was shown recently by the defeat of the highway bonds in Fresno county. Every vote may be needed to insure the success of the State bond issue. Another question to come before the voters is that of authorizing the State Highway Commission to remit a portion of the bond-interest payments in counties where the payment of the entire amount would be too great a burden. The topography of the State is such as to require an unusually heavy expenditure on the State highway system in certain counties. For instance the cost of building about three miles of the Yolo Basin causeway was $400,000. Under the present law, the interest on this entire amount must be obtained by taxing the comparatively small resources of Yolo county, although the benefits of the causeway accrue to the State as a whole. The proposed law would make a more equitable distribution possible.

A CONGRESS of representatives from the so-called 'public-land' States is to be held at Denver during November. Delegates are to be appointed from the 25

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states that still contain public land, and also from Ohio, Illinois, Indiana, and Iowa, where the original Government land has all passed into private ownership. During the period of growth of conservation sentiment throughout the country, there has been a marked lack of unity in the Western States regarding land-legislation. The result has been that the Federal land policy has been largely influenced by entirely conscientious persons residing on the Atlantic Slope, and who were not always well acquainted with western conditions. The recommendations of a truly representative body of delegates from the Western States would doubtless have great weight with both the legislative and the executive branches of the Federal Government. It is to be hoped, however, the members of the proposed Congress do not make the mistake of making recommendations that would mean a virtual return to the lax methods of land administration of a generation ago. Opposition to leasing as such would be particularly unwise. A leasing system for oil, gas, coal, and phosphate lands is a certainty, and the principle may possible be extended to some other mineral lands. It only remains to discuss the provisions that should be incorporated in such leases. Leasing in itself is not objectionable, but an attempt by the exaction of excessive royalties to tax the public-land States for the benefit of the entire country is unjust. Leasing regulations should be framed with a view to promote real conservation and to encourage use but not waste. Whatever royalties are charged should be sufficient only to meet the actual expenses of administration. If the Western States will agree on legislation of this kind there is little doubt that it can be passed. If, however, they fail to present a united front, or if they favor measures looking toward a return to the 'good old days' when land appropriation and land stealing were easy, the prospect of being a Government tenant is the only inducement offered to the man who wishes to risk time and money in developing his country's resources.

Rural Credits for the Contractor

It is interesting to contemplate the love and affection of the politician for the farmer. Witness the rural credit scheme, the vast amount of free information, seeds, and all sorts of things, disseminated gratis by the Department of Agriculture. The reason is obvious: There are so many farmers and they are so well organized. No one, however, seems to have the faintest idea of doing anything for the contractor, who is the man who builds practically everything there is that we absolutely need. In a recent issue we printed an article on the Lindsay-Strathmore irrigation project, wherein is recorded that the low bidders lost a million dollar contract, not because they were regarded as irresponsible, not because they were inexperienced or lacked skill in handling work of this character, but because another contractor had thoughtfully provided himself with financial backing of such strength that he was able to offer a higher price for the bonds of the district than the lowest bidder for the work. There is no denying the fact that the man who can muster an army of dollars behind him can give a powerful push toward the acquisition of business. The contractor who does business entirely on his own money is a rare bird, this is equally true of the merchant or manufacturer; in fact the whole business and commercial fabric is made up of credit interwoven with more credit. A contractor comes far from standing on a par with the merchant or manufacturer as a credit risk at the bank. It is alleged that contracting is hazardous. True enough. So is any occupation, and contracting, properly conducted, is no more hazardous than any other business under the same conditions. Tons of statistics have been compiled and are compiled yearly by various credit agencies, showing how large a proportion of merchants eventually fail in business. These facts seem to be either overlooked or taken as a matter of course. The contractor who can make an equally good showing with merchants as to assets and morals receives scant consideration, while the latter is welcomed with open arms. The ignorance of the banker concerning so technical an occupation as contracting or engineering contracting is responsible in large part for this state of affairs. The banker readily understands the merchant's statement, while discussion of a contract for moving earth at 45 cents per cubic yard, or building a bridge, or driving a tunnel, means little or nothing to the banker while the detailed estimates to him are worse than Greek. Banks are overlooking what might be a profitable business, through neglecting the contractor as a possible customer for their wares. The banker will not hesitate to employ a whole crew of lawyers and pay them regular retainers. They will have expert accountants to check the work of their clerks. Why should not a banker regularly employ a consulting engineer of admitted standing who would be able to pass upon the contractor's estimate, plan of procedure, methods of doing the work, and all of the other conditions governing the cost, and report to the banker whether there was a reasonable chance of the contractor making good on the contract that he has undertaken? Thus the banker would be as secure as with any other risk in advancing funds to the contractor. A rational plan for extension of credit to reputable contractors would in itself reduce the hazards of the business considerably; it would help to eliminate many of the irresponsible contractors who bid by guess-work and are a thorn in the flesh of the skillful man who loses many a job to the reckless or ignorant bidder, knowing that the latter is headed straight for financial wreck. Private owners would soon learn that it would be unwise to award a contract to any bidder who could not get credit from his local banker. It is true that banking houses, and especially those who make a business of underwriting bond issues and other securities, are of necessity compelled to employ engineers to report to them on the engineering phases of a project. The banker who first recognizes the contractor as a customer worth while cultivating, will have found an interesting and profitable extension of his business activity.

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REVIEW OF THE MONTH

WHILE San Francisco is to vote at the coming election on a charter amendment that abolishes practically all regulation upon jitney traffic, the city council of Portland is proposing what we believe is an innovation in such legislation, namely, to treat both street-railroads and jitneys on an equal basis, requiring the same responsibility and continuity of service from each. Franchises governing a set of proposed routes for jitneys have been prepared, and will be offered to the various operators. Should they refuse to accept the terms proposed, which include the obligation to go to the end of the routes on every trip, just as street-cars do, instead of skimming the cream of the short-haul business, jitneys will automatically cease to operate in Portland after November 15.

MAKING fills through the employment of water as a means of carrying and depositing the earthy material is not an unusual type of engineering construction, but a hydraulic fill where the function of the water is to deposit salt is, we believe, something new. Mr. E. R. Morgan, State Engineer of Utah, has proposed a plan for the construction of a highway across the salt marshes adjacent to Great Salt Lake. This plan provides for the construction of two parallel ditches, 1000 feet apart, across the marshes. Into this channel salt water is to be pumped and allowed to evaporate, thus depositing a residue of salt. The process is to be repeated until a solid highway, 1000 feet wide, has been formed. It is believed that this method of constructing a highway in that locality will cost less than any other plan that could be devised.

BONDS of the Fresno Canal & Irrigation Co., formerly held by the Manchester Trust Co., of Manchester, England, have been sold to a syndicate composed of Los Angeles and San Francisco bond-brokers. The bonds are for $1,200,000 and are secured by the entire assets of the canal company, which operates one of the largest irrigation systems in California, taking water from Kings river. This re-financing operation will be followed by the construction of improvements and extensions. Work on the Pine Flat reservoir, however, will not be commenced until the water-users affected have decided definitely whether or not they wish to form an irrigation district to carry out this project. Incidentally, the sale of the bonds is a new indication of the changed financial conditions throughout the world that are making the United States no longer a debtor nation. It will be many years before Europe will have any appreciable amount of capital to invest in American enterprises, in fact, the reverse is likely to be the case.

THE Engineering Foundation has placed its resources at the disposal of the National Research Council, recently appointed by the National Academy of Science at the request of President Wilson. The object of the Council is to co-ordinate the scientific research work of the country in order to secure efficiency in the solution of the problems of war and peace. This is a praiseworthy object, but until the action of the Engineering Foundation, the Council was without funds to pursue it. Even now, the amount available seems to be inadequate. As our readers will probably remember, the original gift of Mr. Ambrose Swasey two years ago, was $200,000. Whether or not any large amount has been added since by other donors, we do not know, but it is hardly likely. The Council could easily spend $200,000 a year, rather than the interest on that amount. However, a beginning can be made, and additional funds provided from public or private sources. It is significant that pure and applied sciences are to be on the same footing in the work of the Council.

PLANS for the re-organization of the Northern Electric Railroad are under discussion before the California State Railroad Commission. This road was planned originally about ten years ago by the late Henry Butters, and seems in general to have been well managed so far as the operating end was concerned. But like so many enterprises in undeveloped territory, it lacked sufficient capital to carry it over the period of waiting for the tributary territory to respond to improved transportation facilities. Financial affairs went from bad to worse until there was no money available even for necessary repairs and maintenance, since every available dollar that could be squeezed out above actual operating expenses was needed to pay interest on bonds and to stand off other creditors. About two years ago, when the end was in sight, Mr. John P. Coghlan was appointed receiver. Mr. Coghlan differed radically from the conventional receiver for a defunct property in that he seems to have made the interests of the security holders his first consideration. Relieved of the necessity of making interest payments, he was able to apply the operating surplus to maintenance, and it is believed that before long the road will be in first-class physical condition. When a suitable plan of re-organization has been agreed upon, it seems not unlikely that the increase of population and productiveness in the territory traversed will ultimately make the Northern Electric Railroad a valuable property. In view of the fact that security holders in so many railroads have been compelled recently to accept a large shrinkage in the book value of their investments, one is inclined to wonder if there is really as

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much water in the stocks of American railroads as popular-magazine economists would have us believe.

AN important factor in the high cost of living is the number of investigations, suits, etc., instituted by Federal and State Governments to determine why the price of something is higher than some legislator or Government employee thinks it should be. Since lifting one's self by one's boot-straps is a mechanical impossibility, the cost of all these proceedings is paid eventually by the general public. The price of gasoline seems to be a matter of particular interest. For a long time, we attempted to keep count of the number of investigations in this connection, but the adding machine broke, so we are unable to give any accurate figures. Recently, however, some of the Federal officials in California have made the discovery that the reputable marketing-companies agree in charging a price which enables them to sell a good quality of gasoline at a fair profit, leaving price-cutting to the irresponsible dealer who mixes equal parts of gasoline and engine distillate. For this fearful crime of price-maintenance, the companies are to be prosecuted under the Sherman Act. Meanwhile, a salaried official of the State of California has attempted to do substantially the same thing with the price of fish, failing not because of any legal interference, and steps are being taken for regulating the price of several farm products in a similar manner. It is interesting to note that one of the principal witnesses for the Government is likely to be the Federal receiver in charge of certain withdrawn lands in the San Joaquin Valley fields. The same official has handicapped the real conservation work of the State Mining Bureau by delay in paying the assessment levied against these lands to provide funds for measures against water-infiltration. Such a course may result in decreasing the amount of oil that can be recovered ultimately from these properties, and thus increase the cost of oil considerably.

ROAD-IMPROVEMENT in California 'broke even' at the county elections held during the past month. In Sacramento county, a bond issue of $1,750,000 for the construction of a system comprising 125 miles of concrete-paved highways was carried by a large majority. In Fresno county, a $3,600,000 issue, providing for 235 miles of concrete-paved highways, 108 miles of gravel highways, and 98 miles of graded but unsurfaced highways in the mountain districts, failed to receive the necessary two-thirds majority. Without wishing to criticize the proponents of the Fresno highway system, we would suggest that the defeat of the bonds may have been because the plans called for so large an expenditure. The experience of Sacramento county is a case in point. Two years ago, an issue of $2,425,000 for highway work was defeated. However, the good-roads advocates were not discouraged, but by eliminating some less important roads were able to reduce the cost of the proposed system. Sacramento and Fresno counties are approximately equal in population and assessed valuation, but the bond issue proposed in Fresno county was over twice that in Sacramento county. It is, of course, true that the greater area and large amount of mountainous country in Fresno county calls for a greater expenditure than in Sacramento county, irrespective of population and property-valuation. Nevertheless, the voter is particularly conservative in these times regarding public expenditure, for which it is hard to blame him. Our advice to the good-roads advocates of Fresno county is to study their plans carefully with a view to the elimination of all but the most necessary highways, and then to try again with a smaller bond-issue. Additions to the highway system may be made later.

LOADS on motor trucks are to be limited, throughout southern California, to 24,000 pounds, including the weight of the vehicle, provided an ordinance proposed at a meeting of county officials is adopted by the several counties. Further recommendations are that the use of trailers with metal tires be prohibited, that the load on a trailer including its own weight be limited to 7000 pounds, that only one trailer be allowed for each truck, that all solid-tire trucks weighing 6000 pounds or more, including the weight of the vehicle, be limited to a speed of 20 miles per hour, and that the width of motor vehicles and trailers be limited to eight feet. There will doubtless be some persons who will oppose such regulations on the ground that the community should provide roads that can stand up under any motor traffic, no matter how heavy. That this is not feasible was demonstrated recently in New York city, where a first-class granite pavement laid on a concrete foundation was practically worn out in a few months by the impact of heavy loads of material excavated from the subways, most of the weight being carried on metal tires. It is probable that the most important advantage of motor trucks is and always will be, their flexibility. For the transportation of large quantities of freight over any considerable distance it is generally cheaper for the community as a whole to use the railroads. Where the motor-truck owner can compete with the railroads on this class of work, it is because the truck-owner has his road-bed constructed and maintained by the public. The cost of such construction and maintenance is properly a charge against motor-truck transportation, and regulations regarding motor-truck traffic should be framed with the idea of making the cost of transportation to the whole community a minimum. Thus in considering steel *v.* rubber tires, the question to be determined is whether it is cheaper to buy new tires or to repair the highways. However, we believe that this is entirely a matter for State rather than county regulation. The field of most trucks covers more than one county, and the passage of divergent ordinances in adjoining counties would impose an unreasonable burden upon truck-users. Furthermore, the counties are not so likely to be in a position to obtain expert advice as the State would be. The State Highway Commission would be able to prepare a code of regulations covering truck traffic that would be passed by the legislature with little or no amendment.

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DISCUSSION

Field-Signaling

The Editor:

Sir—I have noticed with much interest the article in your September issue, with reference to field-signals, and believe your correspondent would be interested in the more complete and well established system of semaphore signals used regularly in the United States Navy for communicating from ship to ship.

The system that your correspondent proposes has the disadvantage, in signaling letters after J in the alphabet, that two symbols must be used instead of one. In the semaphore alphabet, which is formed by different positions of the hands and arms, this is not necessary. The semaphore system is completely worked out with a series of secondary meanings for the different letters. For example, K equals 'No' or negative; P equals affirmative or 'Yes'; L equals preparatory; O is a question or interrogatory, and so forth.

No doubt, many engineers and miners are acquainted with this code, which has been in general use for a long time. Many of the Navy signals are given in the form of a three-letter code and something of this sort could be worked up for field use by surveyors and engineers. The hand-signals can be seen at a considerable distance, and if long signals are to be given at great distances, a pair of flags about 15 inches square on 18-in. sticks will be found a great assistance. Those used in the Navy are half red and half yellow, divided diagonally across the field. This system is much more rapid than the ordinary Morse wig-wag, as but one position of the hands is required to form a complete letter.

A CIVILIAN NAVAL VOLUNTEER.

Chicago, September 20.

The Pit River Highway

The Editor:

Sir—You seem to be interested in highways. Most of your readers are. This is to call your attention to the Pit River route.

Pit river is the one stream cutting the Sierra Nevada range. At the crossing of the Sierras, Pit river is at an elevation of about 2100 ft. At Peck's bridge, east of the Sierras from which point easterly the country is arid, and the snowfall light, the elevation is 2600 ft. The maximum snowfall on this route occurs at about elevation 2000.

There is at present a road approximately parallel to this almost snowless route that runs from Redding to Fall River mills going over a pass of the Sierras at about 4600 ft., which is open for automobiles more than a month earlier than either the Placerville, Auburn, or Quincy routes. The Pit River route would lower this more than 2000 ft. at a point where the snowfall is heaviest. The route is not only the most nearly twelve-month route out of California, but it is a link in the best route east through Nevada *via* Humboldt river, as well as a link in the best route north to Oregon and Washington.

These Lincoln Highway boosters need a locator in the field. Oregon is awake, north-eastern California is awake, Nevada is neglecting her one best east and west route by overlooking the Humboldt river. The Feather River boosters have a route that will cost more and encounter much more snow. The Western Pacific Railway is lower in elevation than any highway along the general route suggested, and it is put out of commission every year.

So if you are giving information about the best route through the Sierra Nevada mountains, you can say it is the Pit River route, and there is no alternate for a twelve-months' open highway.

San Francisco, October 6. GEORGE L. DILLMAN.

An Interesting Book of Misinformation

The Editor:

Sir—Thought your readers might be interested in the following information culled from a recent work entitled, 'Dictionary of the World's Commercial Products,' by J. A. Slater, published by Sir Isaac Pitman & Son, Ltd., London.

"Girder (French, *traverse;* German, *balken;* Spanish, *cuarton*). A beam supported at both ends and used for the purpose of carrying loads placed between the points of support. They are made of cast or wrought iron and steel. For buildings, cast iron is found to be most suitable, wrought iron being mainly employed in the construction of bridges. There are now many combinations of girders used by engineers. Britain suffers severely in the making of girders through foreign competition, especially that of Belgium.

"Steel (French, *acier;* German, *stahl;* Spanish, *acero*). One of the three varieties of iron, the other two being wrought iron and cast iron. It is formed when bars of wrought iron are heated to redness for a time in contact with charcoal. The bar becomes fine-grained instead of fibrous, and the substance is more malleable and more easily fusible than the original bar-iron, and contains carbon to the extent of one or two per cent. When steel is quickly cooled it becomes hard and brittle, and is especially adapted for making cutting tools."

It is interesting also to note that this comprehensive reference work fails to mention either natural or portland cement as a commercial product.

San Francisco, October 9. E. T. THURSTON.

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Proposed Bridge Across San Francisco Bay

By H. DEVEREUX*

A bridge across San Francisco bay should provide ample clearance for shipping without draw-spans, bascules, or lift-bridges. It should be placed so as to offer a minimum of interference with local traffic during and after construction. Its length should be a minimum and it should be easy of access. The grades should not exceed 2½%. Electric-railroad tracks and a highway should be provided. Steam-railroad freight and passenger track can be added at an increased cost. One steam-railway track adds to the weight on the bridge an amount equivalent either to four electric tracks or to the highway. To provide two tracks for steam traffic would double the live load on the structure. The resulting additional cost should be borne by the railroad companies.

The cost of the project should be such that it will not be a burden upon the community, and the entire project should ultimately yield a revenue commensurate with the expenditure. A project improving harbor facilities, which are becoming more congested every year, and offering terminal facilities as part of the plan should have a double value.

The crossing suggested consists of two parts, as follows: a bridge 9750 ft. long and an industrial terminal and inner-harbor railroad 8500 ft. long. The San Francisco approach should be a boulevard extending from First and Harrison to Second and Market streets. The Oakland approach would consist of a boulevard and mole. Rincon Hill was selected on the San Francisco side on account of the supporting ground which shortens the length of the bridge about 4000 ft. On the Oakland side, the bridge strikes the centre of traffic at the end of the Southern Pacific mole, avoids the estuary, and passes between the ferry routes.

Cost of Construction

San Francisco approach, boulevard, according to present plans; 4000 lin. ft. double-track electric-railroad reinforced concrete viaduct to Second and Market streets		$400,000
This may be constructed at any time and is not necessarily a part of the bridge proper.		
Bridge—2000 lin. ft. reinforced concrete viaduct from First and Harrison streets, San Francisco, to the pier-head line, with four electric tracks and a highway; grade, 2½; height, 70 ft.		$800,000
2000 lin. ft. of steel channel spans, middle span 1000 ft. with 150-ft. clearance; grade level, two 500-ft. side spans on 2½% grade:		
Steel, 20,000 tons at $115	$2,300,000	
Four piers at $200,000 each	800,000	
Two towers, 6000 tons steel at $115	690,000	
Tracks, roadway, etc.	200,000	
		3,990,000
2250 lin. ft. in nine 250-ft. spans on 2½% grade:		
Steel, 7200 tons at $115	$828,000	
Nine piers at $90,000 each	810,000	
Tracks, roadway, etc.	225,000	
		1,863,000
2000 lin. ft. steel viaduct on 2½% grade, 50-ft. towers, 90-ft. intermediate spans:		
Steel, 5000 tons at $115	$575,000	
Foundations	280,000	
Tracks, roadway, etc.	200,000	
		1,055,000
1500 lin. ft. concrete viaduct on 2½% grade		600,000
Total		$8,308,000
Add possible increased cost of foundations, administration, contingencies, etc.		1,442,000
Total, 9750 lin. ft. at $1000 per ft.		$9,750,000
Additional cost of provision for steam-railroad passenger and freight traffic, say 30%		3,000,000
Terminal structures—8500 lin. ft. of reinforced concrete causeway at $500 per ft. (This is to be used as an inner harbor and railway and industrial terminal; 5000 ft. will be in San Francisco and 3500 ft. in Oakland.)		4,250,000
3000 lin. ft. of mole with elevated railway and highway, at $250 per ft.		750,000
Total cost of terminal		$5,000,000
Cost of bridge		9,750,000
Total		$14,750,000

Proposed Method of Financing. Since the water frontage which will be obtained will be the property either of the State of California, as owner of the San Francisco water-front, or of the city of Oakland, a considerable part of the funds may be raised by the issue of State Harbor and Oakland Harbor bonds. Since the highway will be free to the public, aid should be given by the State Highway Commission and by the Federal authorities. If a right-of-way for the Hetch-Hetchy Aqueduct was granted across the bridge, it would be possible to divert a portion of the Hetch-Hetchy bond issue for this purpose. The remainder of the amount necessary could be raised by the formation of assessment districts in San Francisco and Oakland, similar to the Twin Peaks Tunnel districts.

A tentative distribution of the amount necessary is as follows:

State Harbor bonds	$3,000,000
Oakland Harbor bonds	3,000,000
State Highway bonds	2,500,000
Federal aid	2,500,000
Right-of-way, Hetch-Hetchy Aqueduct	1,000,000
Assessment districts in San Francisco and Oakland	3,000,000
Total	$15,000,000

*Consulting engineer, 1990 Fell street, San Francisco.

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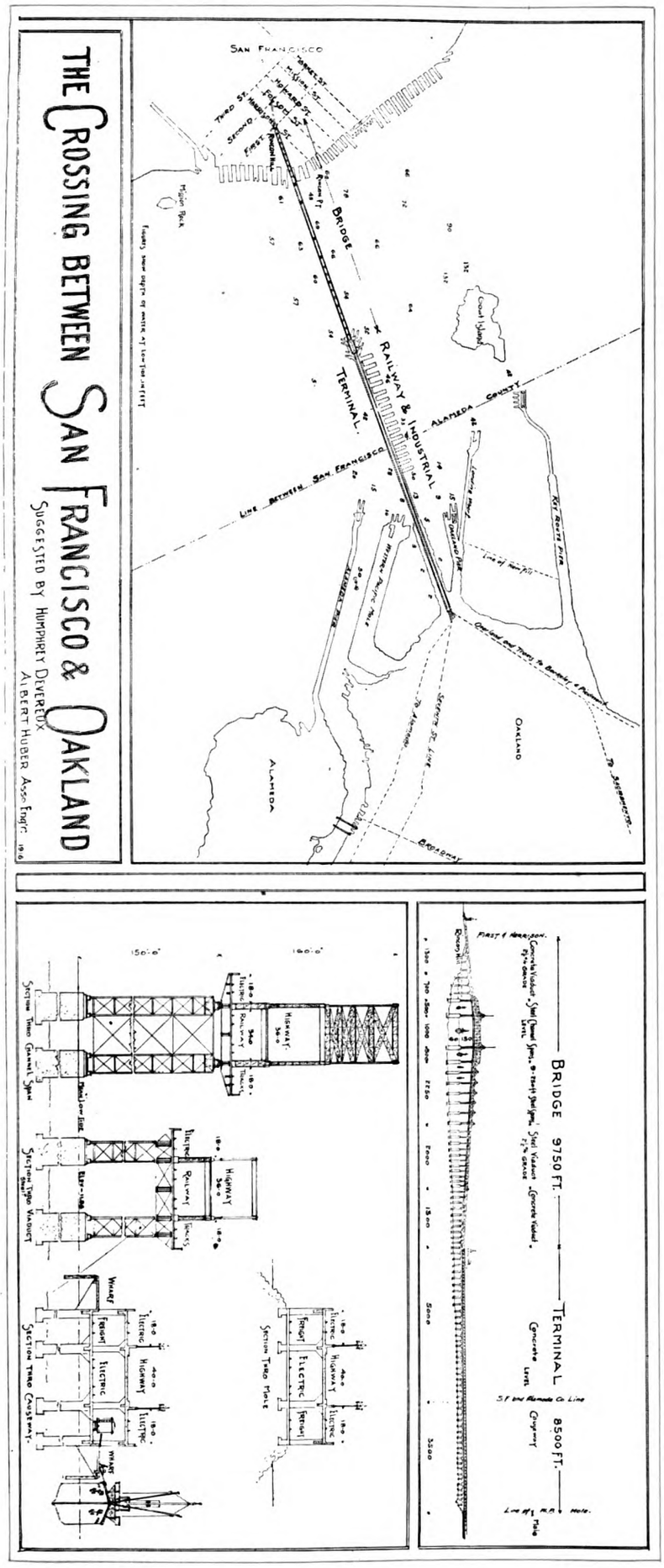

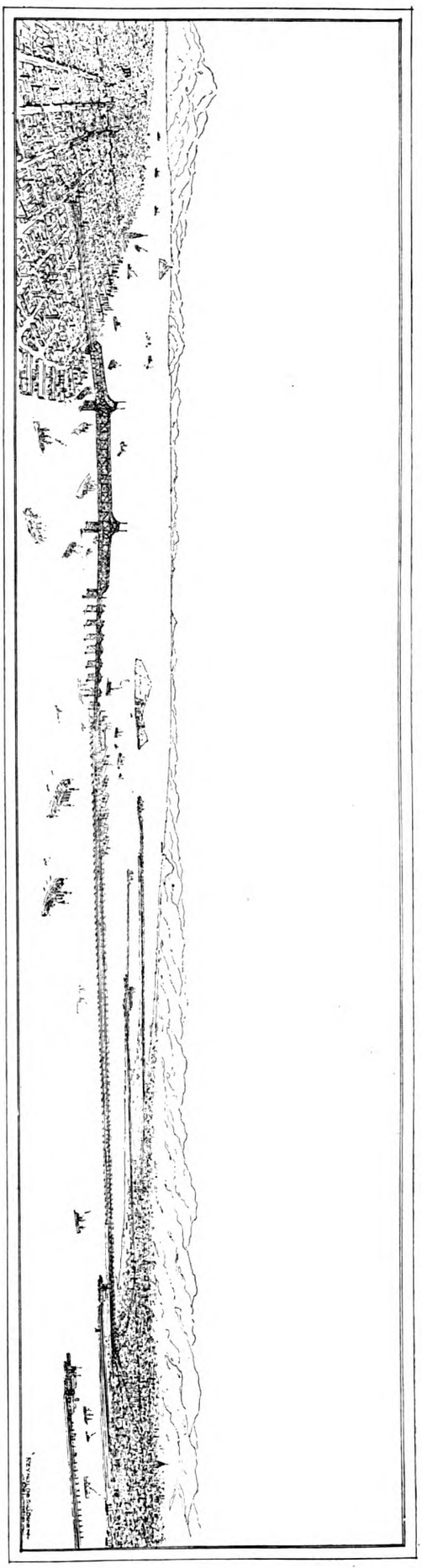

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This amount could be raised by a twenty-year bond issue bearing 5% interest. The interest and sinking fund could be raised by a tax of 2½c. on the present commuter traffic of 40,000,000 annually. The transient traffic should be sufficient to more than pay for the upkeep. The value of an inner harbor to the Bay cities can hardly be expressed in dollars alone. It would give the Bay cities 3½ miles of additional waterfront. An industrial terminal situated where the products of the world pass its portals by land and sea would have a greater financial value than the bridge itself. The Bush Terminal at New York harbor is considered one of the most profitable institutions in the vicinity of the city.

Time Required for Construction. If the terminal and Oakland end of the bridge are let in eight or ten separate contracts, each piece of work is similar in character and magnitude to a single pier. This portion of the structure could then be constructed in one year and the project would be a going concern. In the meantime work on the bridge could be started. The bridge foundations would take one year, the bridge fabrication one year, and the erection and finishing touches another year, making three years in all to complete the work after the funds are available.

The preliminary work required would be to make investigations as to local conditions, to secure permission from the necessary authorities, and to form an organization capable of carrying out the results. The more important steps are as follows:

1. To make borings, soundings, and surveys.
2. To prepare tentative plans to be submitted to the Board of Army Engineers.
3. When approved by the Board of Engineers, to make revised plans and estimates of cost.
4. To form an organization to submit findings, and, if favorable results are obtained, to make plans for construction.

This will cost money, but no project has ever been successful without some initial expenditure. The cost of obtaining the necessary data and submitting plans for approval may be placed at $10,000, and the cost of revised plans and estimates, $15,000, making a total of $25,000. The time required for this work would be about six months.

This preliminary amount should be raised by subscription from those interests which would be benefited by the construction of the bridge. The following tentative distribution is suggested:

City and county of San Francisco	$4,000
San Francisco Down-Town Association	1,000
San Francisco Chamber of Commerce	2,500
Automobile Association of California	2,500
Portland Cement Association	1,000
City of Oakland	4,000
County of Alameda	3,000
Oakland Chamber of Commerce	2,000
City and private interests in Berkeley	2,500
City and private interests in Alameda	2,500
Total	$25,000

RECOMMENDED WORKING UNIT-STRESSES FOR STRUCTURAL TIMBERS

The accompanying table gives working unit-stresses in pounds per square inch for structural timbers used in dry positions, and is compiled mainly from data furnished by the Forest Products Laboratory, Madison, Wisconsin.

WORKING UNIT-STRESSES FOR STRUCTURAL TIMBERS USED IN DRY POSITIONS.

Species of timber	Bending: Stress in extreme fibre	Bending: Horizontal shear stresses	Compression Parallel to grain: short columns	Compression Perpendicular to grain
Fir, Douglas:				
Dense grade	1,600	100	1,200	350
Sound grade	1,300	85	900	300
Hemlock, eastern	1,000	70	700	300
Hemlock, western	1,300	75	900	300
Oak	1,400	125	900	400
Pine, eastern white	900	80	700	250
Pine, Norway	1,100	85	800	300
Pine, southern yellow:				
Dense grade	1,600	125	1,200	350
Sound grade	1,300	85	900	300
Spruce	900	70	600	200
Tamarack	1,200	95	900	350

The safe working stresses given in this table are for timbers with defects limited according to the sections on defects in the rules of the Southern Pine Association for select structural material. 'Dense' southern yellow pine and 'dense' Douglas fir should also conform to the other requirements of this rule. 'Sound' southern yellow pine and 'sound' Douglas fir require no additional qualifications, whereas the other species should, in addition to being graded for defects, have all pieces of exceptionally low density for the species excluded.

The strength of oxy-acetylene welded-pipe connections as compared with screwed connections of equal size, and with the original pipe material is being investigated at the University of Kansas. The results show that the strength of the welded connections ranges from 13 to 71% more than that of the malleable-iron screwed connections. As regards the total cost of welded and screwed connections, the welded is the cheaper in every case. The cost of the fittings is the principal item of expense in the screwed connections. In some cases the cost of the welded joint is less than that of the fitting alone. The lower cost of the welded joint becomes more noticeable as the pipe sizes increase.—*Mechanical World.*

A combined motor truck and industrial railway was used by the Hanlon & Oakes Co. in constructing a concrete road near Sioux City, Iowa. A narrow-gauge railroad four miles long was used to haul materials. A five-ton motor truck straddled the track and hauled twelve 1½-yd. steel dump-cars. The principal advantage of this arrangement is, of course, the saving of the cost of a special locomotive.

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Ornamental Electric Lighting System for Market Street, San Francisco*

On October 5 the inauguration of the new ornamental lighting system on Market street, San Francisco, known as the 'Path of Gold,' was celebrated by illuminations, parades, etc. This system was designed by W. D'Arcy Ryan, the engineer in charge of illumination at the Panama-Pacific Exposition. The operating expense of this system is borne partly by the city, partly by the property-owners, and partly by the United Railroads.

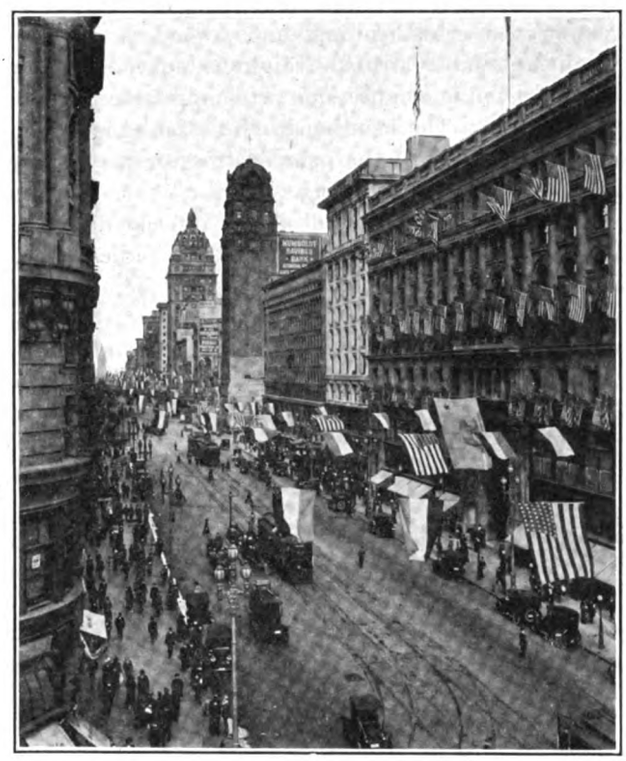
The system extends from the Ferry building along Market street to Seventh street, 7500 ft. The pole adopted for a light-standard is shown in the accompanying photograph. The total height of the poles from the sidewalk to the top of the middle lamp is 32 ft. The poles are painted in imitation bronze with a verd-antique finish. Each pole has three General Electric luminous-arc lamps, using 532 watts, and operating on a rectified-current series-circuit in sets of 75. The average terminal voltage is 82 and the average arc voltage is 78.5. A long-life magnetite electrode is used, the life ranging from 100 to 125 hours.

The total number of poles in the main system on Market street is 137. The average distance between poles is 110 ft. In addition to the main system, 6 poles have been placed in front of the Ferry building, the cost being borne by the State Harbor Commission, and 10 poles will be set on New Montgomery street from Market street southerly, the cost being borne by the Palace Hotel Co. The Ferry Building poles have the same number and type of lamps as those in the main system, while the New Montgomery Street poles are equipped with one arc lamp and two 200-watt mazda lamps.

The system was constructed by the Pacific Gas & Electric Co. The total cost of installation is about $100,000. The yearly operating cost for the main system is $34,753.48, of which the city is to pay $13,251.33; the merchants and property-owners along Market street, $14,926.15; and the United Railroads, $6576, in accordance with the terms of its street-railway franchise, by which it agrees to maintain one lamp on each pole at a cost of $48 per year. The cost of the system per lineal foot of street per year is $4.63. The total building frontage on both sides of the street is about 12,500 ft., making a cost of $2.78 per front foot per year. Estimating the population of the city at $500,000, the city's share of the cost amounts to $0.0265 per capita per year.

The city will maintain the centre-lamp as an all-night lamp at the rate of $96.725 per light per year or $0.265 per night. The merchants, property-owners, and the United Railroads will stand the cost of burning the two side-lamps until midnight, the rate being $78.475 per year, or $0.215 per night. While contracts have been made for three years, it is, of course, expected that the system will be in service for a considerably longer period.

In this connection it is interesting to compare the costs with those of a similar system on Main street, Salt Lake City, also designed by Mr. Ryan, and which was first lighted on September 29. The linear feet of street illuminated is 3828, and the total building frontage is 6370 ft. There are 70 poles, each equipped with three



VIEW OF MARKET STREET, SHOWING COMPLETED SYSTEM.

General Electric luminous-arc lamps. The total cost of installation was $28,220.40, of which the property-owners paid $25,534.39. The total cost of operation for three years, including power, maintenance, etc., is $29,334.65, of which the property-owners pay $25,174.04 and the city $4160.61. Distributing the cost of installation over a period of three years, with interest at 6%, the total cost per year per foot is $3.15. Using a five-year period, the cost is $2.55. Using a seven-year period, the cost is $2.33.

*From data furnished by A. F. Dickerson, General Electric Co., San Francisco.

A ton of Atlantic Ocean water, evaporated, yields 81 lb. of salt; while equal quantities from the Pacific Ocean and Great Salt Lake, Utah, gives 79 and 175 lb., respectively.

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Timber Framing—Part VI

By HENRY D. DEWELL*

Compression Chords and Struts. The importance which is attached to the details of a truss may be inferred from the fact that their design has been discussed before that of the main members. A case where the details of a truss are amply sufficient for the stresses that may come upon them, and the main members are insufficient, seldom if ever occurs.

The present treatment of compression members may be divided into two sections; first, a discussion of solid timber struts subject either to concentric compression alone, or to a combination of concentric compression and cross-bending, and second, a discussion of built-up timber struts, straight or curved, and taking either simple compression or compression combined with bending. The bending in either case may be due to an eccentricity of the primal stress or may be produced by transverse loading.

The calculations for the design of intermediate truss-joints, as given in the previous article, indicated that the struts of a timber truss are usually dependent on the required area for end-bearing, rather than upon the allowable working-stresses from the standpoint of column action. This condition will prevail in the average roof-truss encountered in practice, where the length of the struts is short.

If, in a building truss, the roof joists rest directly upon the upper chord and are rigidly fastened thereto, the latter may be considered to be supported by the joists, and column action will not enter into the determination of its section. Where, on the other hand, the roof joists frame parallel to the truss, or where the joists do not rest directly upon the upper chord, the chord must be considered as a column, and its allowable unit stress determined by the application of a column formula.

Formulas giving the safe working-stresses for timber columns are to be found in almost every text-book on structural engineering, and in most specifications for steel structures. The two formulas most commonly used are those of the American Railway Engineering Association, and the U. S. Department of Agriculture, Forestry Division. The first mentioned is expressed as follows:

$$p = C\left(1 - \frac{1}{60}\,\frac{L}{d}\right), \text{ where}$$

p = working unit stress, in pounds per square inch.

C = safe fibre stress in end compression, in pounds per square inch.

L = length of column in inches.

d = least diameter or dimension of column in inches.

The U. S. Department of Agriculture formula is more complicated. It is

$$p = C\left[\left(\frac{700 + 15c}{700 + 15c + c^2}\right)\right]$$

In this expression, p and C represent the same quantities as in the formula above. In addition,

$c = \frac{L}{d}$, where

L = length of column in inches, and

d = least diameter or dimension of column in inches.

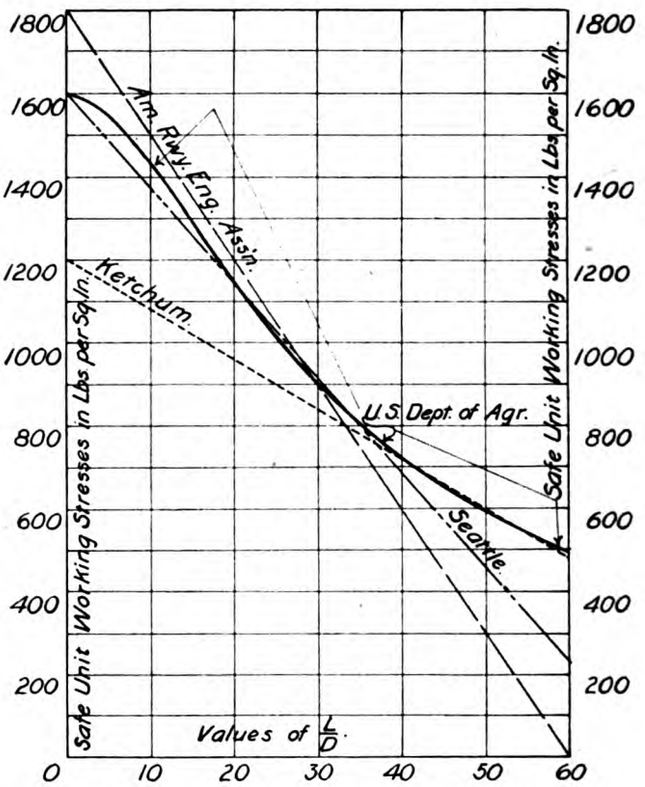

FIG. 41. COMPARISON OF COLUMN FORMULAS.

Two other formulas may be quoted, that of Milo S. Ketchum for mill buildings, and that of the Seattle Building Ordinance, 1914. Using the same nomenclature as before, these two formulas are

$$p = C\left(1 - \frac{1}{100}\,\frac{L}{d}\right), \text{ (Ketchum)}$$

$$p = C\left(1 - \frac{1}{70}\,\frac{L}{d}\right) \text{ (Seattle)}$$

The value of C recommended by the American Railway Engineering Association for railroad bridges and trestles is 1200 lb. per sq. in. for Douglas fir. For highway bridges and trestles, C may be increased to 1500 lb. per sq. in., and for buildings a value of 1800 lb. per sq.

*Consulting engineer, Holbrook Bdg., San Francisco, formerly Chief Structural Engineer, Panama-Pacific International Exposition.

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in. is allowed. Ketchum's recommended value of C for Douglas fir is 1200 lb. per sq. in., while that of the Seattle Ordinance is 1600 lb. per square inch.

For purposes of comparison, these various formulas have been platted in Fig. 41, for the case of use in a building structure, protected from the weather. With the exception of Ketchum's formula, the values as given by the various formulas are not far different between the limits of 15 $\frac{L}{d}$ and 35 $\frac{L}{d}$. Sixteen hundred pounds per square inch is the value recommended in this article for use with Douglas fir in building construction with a grade of lumber of No. 1 Common. The selection of any one of these formulas as against the others for use in designing will usually not materially affect the section of the strut or column. The value of $\frac{L}{d}$ should not exceed 60 for any column or strut.

When computing the necessary size of the upper chord of a truss, the area of sections taken out by rods, bolts, washers, etc., must not be forgotten, and the proper allowance must be made for these losses of effective area. The fit of the web compression-members or the butt-blocks, if used, may be assumed to be such that the joint is 100% efficient, if an allowance for their cuts would mean a serious increase in cost. Otherwise, it will be better to make some allowance for poor fitting. The relation of actual load on the truss to probable load, as well as other considerations make this point one to be decided by the engineer for the particular case in hand.

Composite or Laminated Columns. As a preliminary to this discussion, the general statement may be made that composite or laminated columns and struts, that is, columns built up of dimension stock, and spiked or bolted together, should be avoided whenever possible. In designing roof trusses for armories, skating-rinks, etc., it is often necessary to use trusses with arched chords. In such instances, laminated chords acting in compression and in tension may be a necessity. The requirement of bending the individual members of the chords to a curve of a comparatively short radius decrees that these members be either built of boards or of comparatively thin planking. The peculiar complications of such a truss will be discussed a little later.

For the general case of built-up columns, it may be argued that the average quality of timber in such a composite column is higher than that of a solid stick. On the other hand, and by far counter-balancing this small advantage, is the practical impossibility of making the built-up column act as a single stick. Composite columns may be separated into two classes, the first class comprising those constructed of a number of boards or planks, laid face to face, and bolted or nailed together, and the second class, consisting of those columns built of several laminations, with their edges tied together by cover plates. These two classes are illustrated by Fig. 42, *a* and *b*. Tests[1] have shown conclusively that the first class, when bolted together at the ends and the middle, will act as individual sticks. Expressed in another way, it may be said that the strength of a composite

FIG. 42, *a* AND *b*. TYPES OF LAMINATED COLUMNS.

column, without cover-plates, and bolted together, is the sum of the strengths of the individual boards or planks, acting as separate columns with a length equal to that of the whole column. When, in place of, or in addition to, the bolting, such laminated sticks are spiked together thoroughly, the total strength of the column is in excess of the sum of the individual sticks.

In an endeavor to throw some light on this subject, I made a few tests in 1915 on some small composite columns. The results were published in *Engineering News*, Vol. 75, No. 7, February 17, 1916. Five built-up columns, constructed in three different ways, with a 3 by 4-in. section, and 23 in. long, were tested in compression to failure, and for comparison, two solid timbers, of the same cross-section and length, were also tested. The details of the test columns are shown in Fig. 43, while the load-deformation curves are shown in Fig. 44. The lumber was No. 1 common Douglas fir, with ends true and square, and surfaced. The individual boards were surfaced on one side. Fig. 45 shows the columns after failure.

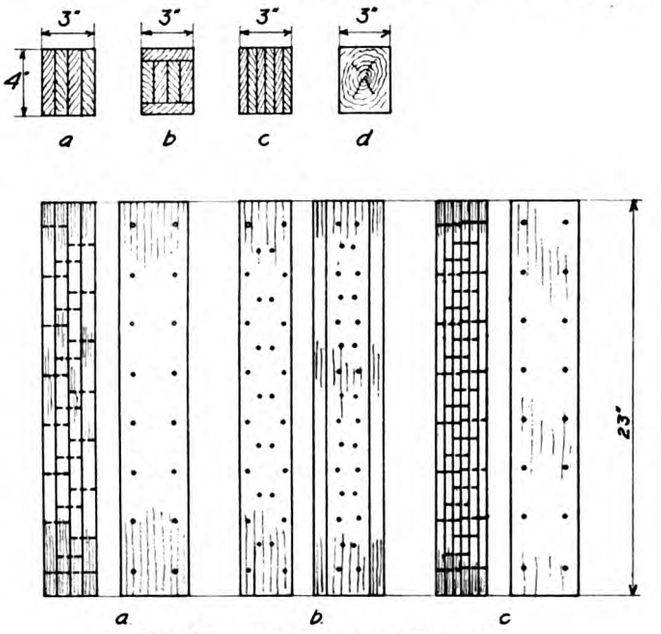

FIG. 43. DETAILS OF TEST COLUMNS.

The column of Type *b* was found to be as strong as the single stick. At the ultimate load, however, the individual pieces separated somewhat. The failure in this column was a combination of crushing, resulting from

[1]See 'The Elasticity and Resistance of the Materials of Engineering,' by Wm. H. Burr, 1905 edition, pp. 539-541; 'The Materials of Engineering,' by J. B. Johnson, pp. 682-683; also 'Structural Details,' by H. S. Jacoby, pp. 210 and 217.

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straight compression, and of tension, due to the bending of the individual sticks. The columns of Type *c* were far deficient in strength as compared to the other types. The ratio of length to least diameter of the individual boards of the *c* columns was 46, while the corresponding quantity for the *a* columns was 31. The $\frac{L}{d}$ for the solid sticks was $7\frac{2}{3}$. The ultimate strengths of these

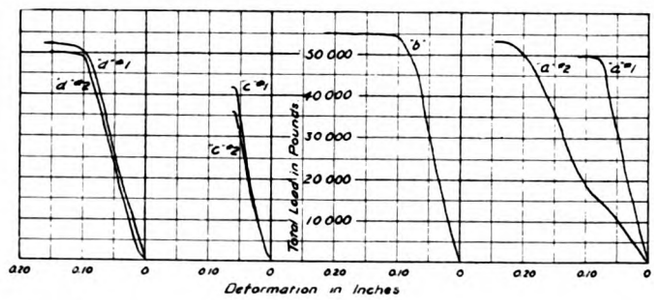

FIG. 44. LOAD-DEFORMATION CURVES OF LAMINATED COLUMNS.

three types of columns as computed by the formula of the U. S. Department of Agriculture, assuming the ultimate strength of the timber in end-compression to have been 4500 lb. per sq. in., and assuming the sticks to have acted as individual columns, would be as follows:

TABLE XIV

	Type *a*	Type *b*	Type *c*
$\frac{L}{d}$	31	31	46
Ultimate strength (computed)	29,600 lb.	29,600 lb.	21,400 lb.
Ultimate strength (actual)	49,000 lb.	50,000 lb.	38,000 lb.
Efficiency	98%	100%	76%
Average of values of line (2) and strength computed as solid sticks	39,900 lb.		35,800 lb.

While the small number of the tests, and the diminu-

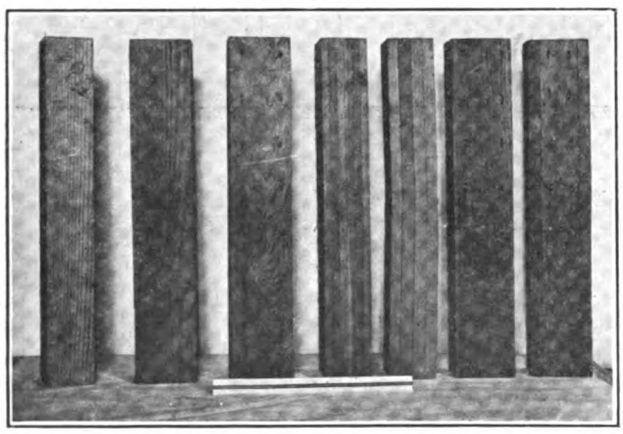

FIG. 45. TEST-COLUMNS AFTER FAILURE.

tive size of the specimens does not warrant forming too definite conclusions to be extended to large-size columns, it is evident that the columns of Type *b* or the 'cover-plate' type are much superior in strength to the plain laminated type. This is what might be expected from a theoretical standpoint. An inspection of the values of the ultimate strengths as given in Table XIV indicates that the actual strengths of the columns of Types *a* and *c* are not far from the mean of the strengths computed first as a solid stick and then as a summation of individual sticks. In this connection, it is well to note that the spiking of these composite columns was exceedingly thorough, and such effective spiking could not be expected in actual construction. Even though equivalent spiking were to be specified and shown on the drawings of actual columns, it would be a Herculean task for the inspector to secure this result in the field. When, in addition to the practical impossibility of obtaining sufficient nailing, it is remembered that in the case of a laminated chord of a truss, and also in the case of many composite columns, the individual boards or planks splice at various points throughout the length of the chord or column, it will be realized that another element of weakness is introduced, namely, the failure of the carpenter invariably to secure perfect butt-joints in the splices. Any such imperfect splice will, of course, put an additional stress upon the spikes, which must then transmit the load of the spliced timber to the adjoining boards.

From a consideration of the above factors, and until further tests prove otherwise, I recommend that the strength of a composite column of the type of Fig. 42*a* be taken at 80% of the mean of the strengths computed (1) as a solid stick, and (2) as a summation of the strengths of the individual sticks considered as individual columns. For columns of the type as illustrated in Fig. 42*b*, or the 'cover-plate' type, I recommend that the strength be taken as 80% of that of a solid stick of equal cross-section and length.

Curved Laminated Truss-Chords in Compression and Tension. The preceding discussion has considered only straight columns or struts. The much more complicated case of a curved laminated truss-chord must now be treated. The subject is one that is generally avoided in the few text-books on timber-framing, or at best is dismissed with brief mention. However, as has been stated in a former paragraph, the case of a laminated truss-chord, acting in compression or in tension, is one that occurs frequently, and it therefore becomes of vital importance to establish, if possible, average safe working-stresses for such chords. In addition to the average unit-stress on the section, there is introduced the complication of secondary stresses. Due to the fact that in the solution for the stresses of such a truss, the chords are assumed to be straight between panel-points, when actually they are curved, there is produced a bending in the chords, equal to the total main stress in the chord multiplied by the maximum eccentricity of the centre line of the chord measured from the straight line connecting the two adjacent panel-points, except as this bending moment may be modified by conditions of continuity and fixedness of the chord. Further, as has been mentioned previously, there exists a considerable initial stress in each lamination of the chord, resulting from springing the boards to the required curve during con-

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struction. The amount of the bending due to the assumption, in the stress analysis, of a chord of straight segments may be computed; also the initial stress in each board due to framing to a curve may be found. The difficulty arises in determining the actual efficiency of such a composite beam in resisting the bending due to the eccentricity of the main stress,[2] and in deciding for what length of time the modulus of elasticity of the timber remains constant. With regard to the first consideration, the efficiency of the chord-section to withstand bending depends on the number and position of the splices of the boards, and the ability of the nails to resist, without slip, the longitudinal shear between the laminations. Remembering that the nails are also called upon to resist the shear due to column action, and, to a large extent, that due to the initial bending of the boards, and further, as shown in a previous article, that nailed joints slip at a comparatively small load, it will be realized that the laminated chord should not be credited with a high efficiency.[3]

The complications and the uncertainties of the problem can best be appreciated by a practical example. For this purpose, Fig. 46 shows a skeleton diagram of one of the three-hinged roof arches of the main group of buildings of the Panama-Pacific International Exposition. In this figure the sizes of the various members of the arch are indicated. Fig. 47 gives a detail of a portion of the lower chord of the arch. The maximum compressive stress is 42,400 lb., while the maximum tension is 45,400 lb. These stresses are due to the following loads:

	Lb. per sq. ft.
(1) Dead load plus live load	35
(2) Dead load plus wind load	

The wind on the side walls, or the vertical portion of

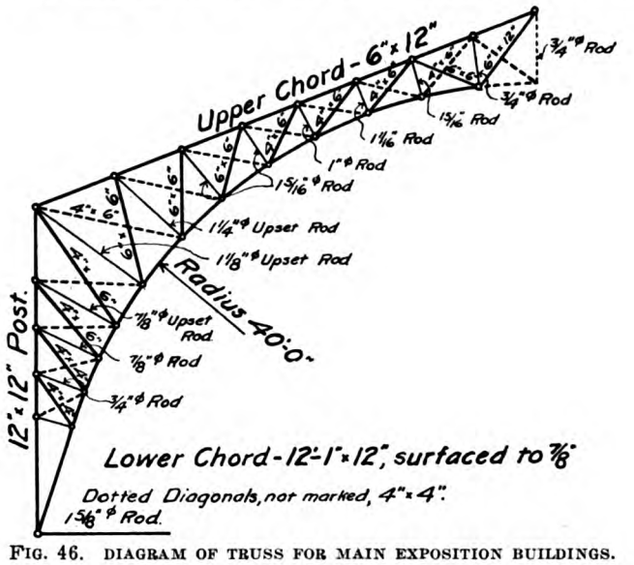

FIG. 46. DIAGRAM OF TRUSS FOR MAIN EXPOSITION BUILDINGS.

the truss, was taken at 20 lb. per sq. ft., and the wind on the roof in accordance with Duchemin's formula, with $P = 30$ lb. per sq. ft. For the condition of dead

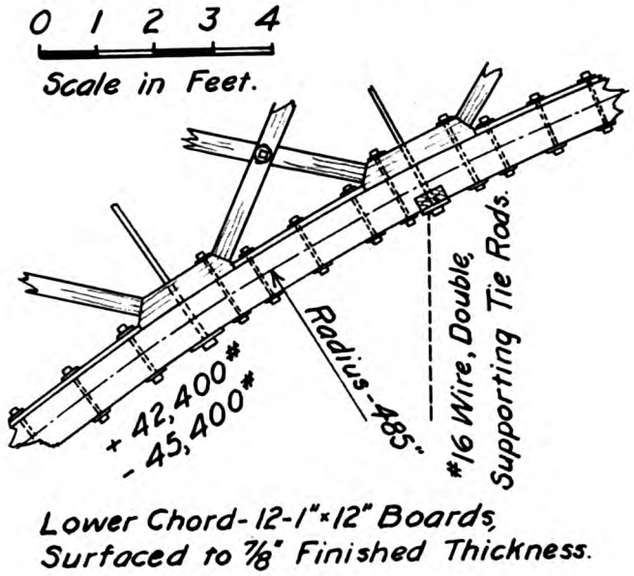

FIG. 47. DETAIL OF PART OF LOWER CHORD.

load alone, the lower chord is in compression, with a stress of approximately 24,200 pounds.

Referring to Fig. 47, the eccentricity of the centre line of the chord from a straight line connecting the adjacent panel points is 1 in. The bending moment due to this eccentricity, disregarding the effect of continuity of the chord, is therefore 42,400 in.-lb. As the chord is continuous, and held rigidly at the panel-points by the long butt-blocks, the apparent bending moment may be reduced by the factor $\frac{3}{4}$, making the effective bending

[2] Reference is made to 'Graphical Analysis of Roof Trusses,' by Charles E. Greene, 1905 edition, p. 82, and the following statement is quoted from the paragraph entitled 'Curved Beams:' "If the planks are bent to the curve and laid upon one another, this combination is not nearly so effective as the former (scarfed boards laid side by side, the plane of the boards being parallel to the plane of the loading), but it can be more cheaply made. The lack of efficiency arises from the unsatisfactory resistance offered to shear between the layers by the bolts or spikes. The strength to resist bending moment will be intermediate between that of a solid timber and that of the several planks of which it is composed, with a deduction of one for a probable joint. If the curved member has a direct force acting upon it and a moment arising from its curvature, the treatment will follow the same lines; but the joints, if there are any, will be more detrimental in case there is tension at any section. Such curved pieces are sometimes used in open timber trusses for effect, but their efficiency is low on account of the large moment due to curvature."

[3] In framing a curved laminated truss chord, such as the one under discussion, the required curve is marked out on the floor of the fabricating platform, and blocks are then nailed to the floor along the curve. These blocks hold the boards in position. One after the other, the boards are then bent to the curve, each successive board being nailed to the preceding one. Both chords are usually framed on the floor in their correct relative position, and the web members, struts and rods, are then placed in the truss. The truss is often fabricated completely before the blocks are released. The chords are thus to some extent maintained in their correct shape by the action of the web members against the butt-blocks, and the butt-blocks against the first boards. The nails and the bolts binding the board or boards between the butt-blocks are in shear. The statement above, of which this note is an explanation, is believed, then, to be a reasonable one.

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moment 31,800 in.-lb. If the chord were a solid stick, the section modulus would be $\frac{1}{6} \times 12 \times (10.5)^2 = 220.5$, and the maximum fiber stress would correspondingly be $\frac{31800}{220.5} = 144$ lb. per sq. in. The actual efficiency will be taken in accordance with the recommendations of Mr. Greene, namely, as the average between the section modulus of the solid stick of equivalent cross-section and the sum of the section moduli of the separate boards, minus one. In other words, the efficiency of the chord will be taken at $\frac{118.6}{220.5} = 0.54$, or say one-half. The actual maximum fibre-stress due to the bending will therefore be twice 144 or 288 lb. per square inch.

For finding the initial stress due to the springing of the boards to the curve of the chord, the formula

$$M = \frac{EI}{R}$$

will be used. This formula is one of the forms of expressing the bending moment in any beam according to the Common Theory of Flexure.

M = bending moment in inch-pounds.
E = modulus of elasticity.
I = moment of inertia in inches.
R = radius of curvature in inches.

We may also write the equation,

$$M = K \tfrac{1}{6} bd^2, \text{ where}$$

K = maximum unit fiber-stress in any board,
b = width of any one board, and
d = depth of any one board, both in inches.

Equating the two expressions, we have

$$\frac{1}{6} Kbd^2 = \frac{EI}{R} = E \frac{1}{12} bd^3 \frac{1}{R}, \text{ whence}$$

$$K = \frac{1}{2} \frac{dE}{R}$$

The radius of curvature may be assumed, for practical purposes, to be constant for all boards of the chord, and its value will be taken at 485 in. Then,

$$K = \tfrac{1}{2} \times \tfrac{7}{8} \times \frac{1}{485} \times 1{,}500{,}000 = 1350 \text{ lb. per sq. in.}$$

The average gross unit compression in the chord is $\frac{42400}{12 \times 10.5} = 337$ lb. per sq. in. To find the maximum unit compressive stress in the chord, the three values found above must be added. Thus, adding $288 + 1350 + 337$, the maximum compressive stress is seen to be 1975 lb. per square inch.

The unsupported length of the boards may be taken at 33 in., or slightly more than the distance between the ends of the butt-blocks. Due to the continuous chord, and the long butt-blocks bolted through the chord, which produce to a great degree the effect of 'fixedness,' the length of the column may be reduced to $\frac{1}{2} \times 33 = 16\frac{1}{2}$ in. The ratio of length to least width is therefore $16\frac{1}{2} \times \frac{8}{7} = 19$. The safe unit stress is then 1170 lb. per sq. in., using the U. S. Department of Agriculture formula, with $C = 1600$. If, on the other hand, the allowable unit-stress be determined on the basis of column action of the chord as a whole, the unit-stress will be, using the same formula, 1600 lb. per sq. in. Using the recommendations set forth previously, the allowable unit fibre stress would be 80% of the half su mof $1170 + 1600$, or 1100 lb. per sq. in. The computed maximum stress is therefore considerably in excess of the allowable. It must be stated, however, that the lumber in these laminated chords was clear and straight grained, it being so specified and furnished. Consequently, its ultimate strength was considerably in excess of the average grade to which the column formula applies. Further, the computed fibre stresses are for the condition of dead load and wind. With dead load alone acting on the truss, the maximum fibre stress would be 1650 lb. per sq. in. Considering the fact that this truss was for a temporary building, the unit stresses, while high, were considered as safe. The strength of the long butt blocks, dapped into the chords, and bolted thereto is an important factor in stiffening the laminated chord in compression, and unless such construction exists, the effective length of column should be taken as the panel length of the truss.

In a similar manner, the maximum tensile stress may be found. The stress due to springing the boards to position is the same as before; the stress due to secondary bending is greater in the proportion of the principal stresses, or $\frac{45400}{42400} \times 288 = 308$ lb. per sq. in. The average unit stress in tension on the whole chord is $\frac{45400}{126} = 360$ lb. per sq. in. An allowance must be made in this case for splicing of the boards; it will be assumed that the chord has an efficiency of 75%. The average stress of 360 lb. per sq. in. must therefore be increased by the factor $\frac{4}{3}$, resulting in an actual unit stress of 480 lb. per sq. in. Finally, combining all the unit stresses we have a total unit stress of $1350 + 308 + 480 = 2138$ lb. per sq. in. For the grade of timber used, this is not an excessive unit stress.

The change in the modulus of elasticity of the timber has been mentioned. It is a fact, established by tests, that if a load be left on a timber beam for some length of time, the modulus of elasticity of the timber will drop to approximately one-half its value for temporary loads. This phenomenon is generally expressed by the recommendation that, in computing the deflection of timber beams, the modulus of elasticity for a 'dead' or constant load be taken at one-half the value used for 'live' or temporary loads. It is believed reasonable, therefore, to state that while the stresses due to springing the boards of the truss-chord illustrated above are actual stresses at the time of framing, a change in the properties of the timber eventually takes place, resulting in a decrease in the modulus of elasticity, and consequently, a diminution in the stress due to shaping the boards to the curve. Just how long a time is required for this change to take place it is difficult to say, the time being dependent to some extent on the original moisture-content, the amount of bending introduced in the chords, and the protection from the weather in the

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structure of which it is a part.[4] It is believed the initial stresses are reduced within a few months nearly one-half.

The complicated conditions existing in a curved, laminated truss-chord, will now be appreciated; also the force of the statement that such a section should be avoided whenever possible. The calculations and the reasoning of the above discussion may seem to be both doubtful in accuracy and cumbersome. I am frank to admit that the result reached in the illustration chosen rests upon a number of assumptions whose validity cannot, perhaps, be definitely proved. However, the main tenets are true: the initial stress due to springing the boards to a curve does exist, and approximately to the amount computed, when the boards are first bent; afterward, this stress undoubtedly decreases; also there does exist a secondary stress of bending due to the curve of the chord. The actual amount of the reduction of the initial bending stresses is somewhat uncertain, but the assumptions made herein are believed to be fair.

Curved laminated chords are more efficient in tension than in compression, and a truss with the compression chord of solid members, even if broken and spliced at every panel-point, is in many cases to be preferred over one in which both compression and tension chords are curved laminated sections. This statement is made advisedly. I have seen instances of laminated curved compression-chords in a badly buckled condition.

Timber Tension-Members. The tension chord of a truss, when framed in timber, needs no further discussion. It has been shown above, and also in the treatment of end-details, that secondary stresses very often add considerably to the primary stresses. Timber will seldom fail in straight tension; the details will give first. For this reason, it might seem reasonable to use a much higher unit stress in tension than has been recommended in these articles. However, because of the uncertainties of the actual amount of secondary stresses, and the variation in the structure of the material, it is recommended that from 1500 to 1800 lb. per sq. in. be taken as the extreme limit for tension in the case of live and dead loads for permanent structures.

Tension-Rods. The selection of the proper size of tension rods is not merely the problem of dividing the maximum stress by the allowable unit stress. Certain other factors enter into the problem from the practical standpoint, and these will be discussed briefly.

To the computed stress in a tension rod of a truss, as found from the stress analysis, it is well to add an initial tension. In fabricating a truss, camber is usually introduced, and largely by means of springing the chords, cutting the web compression members to fit, and holding the truss in this strained position by tension in the rods. The amount of this initial tension that should be added may be taken at from 1500 lb. for the smaller roof trusses to 3000 lb. for the larger trusses, the values given being for each rod of the truss.

Either plain or upset rods may be used, the former being cheaper for the shorter rods, and the latter economical for the longer rods. The dividing line for any case can be determined easily from local prices. In using plain rods, it must not be forgotten to take the area at the base of the threads as the net section in determining the size of rod to be used. If upset rods are specified in designing the truss, great care must be exercised to see that no welded rods are furnished. It is the custom in some small shops, when rods with upset ends are specified, to weld 'upsets' to the body of the rods. This practice results largely from the fact that such shops have no upsetting machines. Welds in plain rods are, of course, a possibility, and the inspector must needs watch for them, especially in long rods, but their occurrence is not so probable as in the case of upset rods.

Another factor to be considered in the design of tension steel is the quality of steel to be expected. This consideration will affect the working stress to be used. On the Pacific Coast at least, re-rolled steel is used almost exclusively for the stock sizes of rods. The principal objection to re-rolled steel is its variable composition, as shown by its fibrous, laminated fracture. Again, although medium steel may be specified, wrought iron may be furnished. The quality of the material in the tension rods of a truss can only be determined by tests, and these are not always convenient or possible to make. It is of interest to the designer of such trusses, therefore, to be familiar with the limitations of the market, and his design may be modified accordingly. For the purpose of indicating the nature of the metal commonly furnished under specifications calling for medium steel corresponding to standard specifications, there is given below the results of some tests on various sizes of rods taken from material submitted by contractors under specifications calling for medium steel to correspond to

[4]For the purpose of obtaining some definite measurement of the amount of this initial stress remaining in such laminated chords, I am at present conducting some tests on the boards of the chords of one of the Trusses 'A' of the Panama-Pacific International Exposition (one of the same trusses just discussed) through the kindness of C. H. Munson, assistant to the director of works. On September 29, 1916, three laminations were removed from a chord which was built approximately two and one-half years ago. The length of the chord, and the middle ordinate of the arc of the approximate circle to which the boards sprang back on being released were measured, and from these measurements the radii of the circles to which the boards returned have been computed. Of the three boards measured, the radii of their respective circles were 95, 81, and 96 ft., or an average of 91 ft. The same boards were again measured on October 14, 1916, and the respective radii were found to have increased to 128 ft., 129.5 ft., and 132 ft., or an average of 130 ft. As the fibre stress due to the curvature is in direct proportion to the radius of curvature, it may be stated that the present measurements indicate that $\frac{40}{(130-40)}$ of the initial stress remained in the boards up to the last date mentioned, or, in other words, that approximately 45% of the initial stress still remained in the chords. This calculation is on the assumption that the modulus of elasticity of the timber has not changed. The boards are being observed for further change. They are stored inside a warehouse, and lie on their edges, so that they are free to take their natural shape.

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the standard specifications adopted by the Association of American Steel Manufacturers.

TABLE XV

RESULTS OF TESTS ON ROUND STEEL TRUSS RODS

Nominal dimensions, inches	1½	1¼	1⅛
Actual dimensions, in	1.498	1.238	1.129
Actual area, sq. in	1.7624	1.203	1.001
Yield point, actual load, lb	53,070	37,780	33,150
Yield point, lb. per sq. in	30,112	31,404	33,117
Ultimate strength, actual load, lb	88,130	61,620	51,960
Ultimate strength, lb. per sq. in	50,005	51,221	51,908
Elongation in 8 inches, in	2.00	2.30	2.35
Elongation, per cent	25.00	28.75	29.25
Dimensions, reduced section	1.240	0.960	0.824
Area, reduced section	1.207	0.7238	0.5332
Reduction of area, per cent	31.5	39.83	46.73

Character of fracture: 1½-in. round steel truss rods, characteristic, badly laminated, small distinct bars in mass; 1¼-in., part cup, characteristic, badly laminated; 1⅛-in., characteristic, slightly laminated.

Comparing these results with the specifications of the Association of American Steel Manufacturers, the ultimate strength is below the limit for structural steel (60,000 lb. per sq. in.), and somewhat below the limit set by the specifications of the American Society for Testing Materials (55,000–65,000 lb. per sq. in.); the elastic limit is satisfactory; the percentage of elongation is satisfactory, the requirement being a minimum percentage on an 8-in. length of $\frac{1400000}{\text{Ult. Strength}} = \frac{1400000}{51000}$ $= 27.5\%$ for material not over $\frac{3}{4}$ in. in thickness, with an allowable deduction of 1% for each $\frac{1}{8}$-in. increase in thickness, except that the minimum elongation shall not be less than 18%. For the 1⅛-in. rod, the minimum elongation required is, according to the rule above, 24.5%; and for the 1½-in. rod, the minimum is 21.5%.

The testing company reporting the above tests classified the material as wrought iron. In my opinion, this classification was erroneous; the fracture had somewhat of the fibrous texture characteristic of wrought iron, as opposed to the silky or granular fracture of steel, but was actually what may be described as a mild 'mongrel' steel. The laminated composition is characteristic of the material, and shows to better, or worse, advantage in the case of plates. Fig. 48 shows a typical specimen.

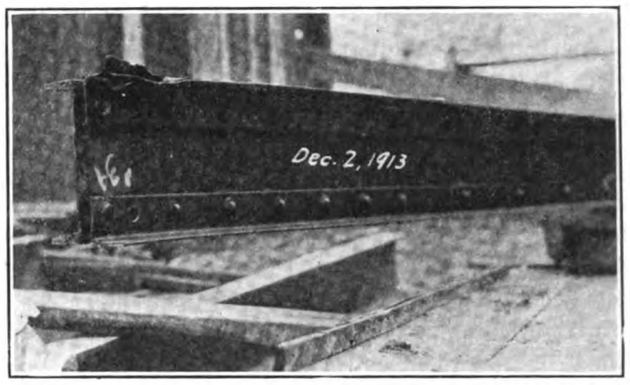

FIG. 48. SPECIMEN OF DEFECTIVE RE-ROLLED STEEL.

Table XVI gives the results of some other truss rods and also of bolts. These results are introduced for the purpose of giving a general idea of the fairly uniform characteristics of the steel of this class. It will be noticed that the elastic limit is quite high.

For use in rods, or plate connections taking tension alone, it is believed that the material may be used with confidence, employing a stress of 16,000 lb. per sq. in. for dead and live load. For important work, such as where the full live load is a certainty, this steel should

TABLE XVI

TENSION TESTS ON TRUSS RODS AND BOLTS

Material	¾-in. bolt	¾-in. bolt	Truss rod	Truss rod	Truss rod	Truss rod	Truss rod
Mark or number	No. 1	No. 2	*A**	*B*†	*C*†	*D**	*E*†
Dimensions of cross-section, in	0.736	0.60	0.858	0.855‡	0.865‡	0.983	0.988
Area of cross-section, sq. in	0.425	0.283	0.578	0.574	0.588	0.759	0.767
Load at yield point, lb	14,300	13,820	18,700	.....	.....	24,000	.....
Strength at yield point, lb. per sq. in	33,600	48,900	32,400	.....	.....	31,700	.....
Maximum load, lb	20,890	17,830	27,500	28,850	28,950	36,000	36,400
Maximum strength, lb. per sq. in	49,000	63,000	47,500	50,400	49,300	47,400	47,500
Elongation in 8 inches	.....	.....	1.4**	.....	.....	1.93	.....
Per cent elongation in 8 inches	.....	.....	17.5	.....	.....	24.1	.....
Dimensions of reduced cross-section, in.	.....	.....	0.60	.....	.....	0.65	.....
Area of reduced cross-section, sq. in	.....	.....	0.283	.....	.....	0.331	.....
Per cent reduction of area	.....	.....	51	.....	.....	56.5	.....
Character of fracture	.....	.....	fibrous	fibrous	fibrous	fibrous	fibrous
Speed of machine, inches per minute	0.04	0.04	0.04	0.04	0.04	0.04	0.04

Remarks:

Bolt No. 1—Test of strength of head of bolt. Body of bolt failed.

Bolt No. 2—Test of strength of thread of bolt. Bolt failed in thread.

Dimensions at root of thread.

*This test on centre portion of a truss-rod.

†Test on upset rod.

‡Diameter near centre of rod.

**Failed outside of gauge points.

Truss Rod A—End near upset badly twisted; 8 threads per inch; diameter root of thread, 1.04 in.; failed in body of rod.

Truss Rod B—Diameter near upset, 0.834 in.; failed in body of rod.

Truss Rod E—Diameter near centre of rod, 0.988 in.; diameter near upset, 0.983 in; diameter of root of thread, 1.07 in.; failed in body of rod.

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not be used, and rigid adherence to the standard specifications should be required.

Bracing-Trusses. Bracing-trusses in building construction may serve one or all of three purposes, first, that of stiffening the top or compression chords of the main roof-trusses, second, providing general stiffness to the building against wind, and third, supporting the roof joists directly, and transferring this load to the main roof-trusses. In the latter event, the bracing-trusses are generally referred to as purlin trusses. It

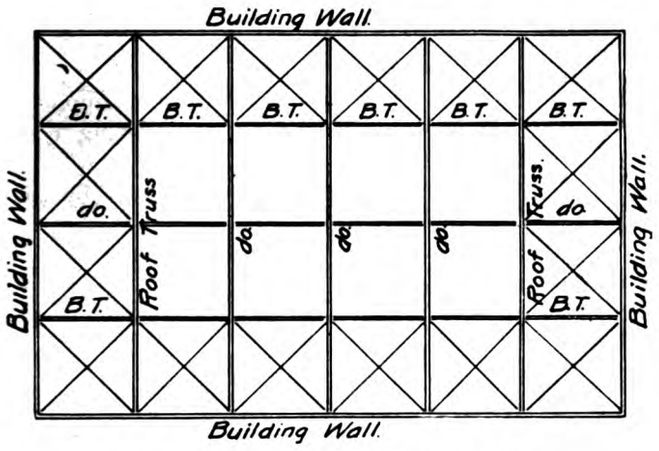

FIG. 49. GENERAL PLAN OF BRACING-TRUSSES.

might appear at first thought that the most economical arrangement of framing would be secured by using purlin trusses, and utilizing them as bracing-trusses. This is not necessarily true, however. While, by this scheme, the upper chords of the main trusses are relieved of cross-bending from the roof joists, the additional material necessary in the bracing-trusses to enable them to carry the roof is usually considerable. In addition, more steel is required in the main roof-trusses, because the shear in these trusses is a constant from the supporting columns to the point of attachment of the purlin trusses, and for requirements of general stiffness, the rods of each main truss between the purlin trusses cannot be altogether omitted, even though the shear due to roof covering and joists is zero. Because of the varying factors of span and spacing of the main roof-trusses, direction of slope of the roof, and possible limitations of clearances and ceilings, no hard and fast rule as to the most economical arrangement of framing can be stated. I have found, however, that in actual cost of construction, there is little difference between a roof framed with the joists resting directly upon the chords of the main trusses, and one in which purlin trusses are employed.

Considering the case of a bracing-truss which carries no roof load, the principal points to be observed are to make its chords of a section capable of taking compression, and to see that it has a good and rigid attachment to the chords of the main trusses. Theoretically, the lower or tension chord of a roof-truss needs no stiffening. Practically, however, it is well to support it laterally, not alone to keep it from warping out of shape, but also for the purpose of adding general stiffness to the building frame.

The actual stress which may come upon a bracing-truss is usually indeterminate. In many cases, however, a definite scheme of wind bracing may be provided, in which the bracing trusses play an important part. For example, the roof may be stiffened to act as a horizontal beam against wind pressure, transferring the wind loads to the end or side-walls, or to columns and walls. In such cases, diagonal rods are usually introduced in the plane of the roof-joists, the upper chords of the roof-trusses and the bracing-trusses acting as the chords of the horizontal wind-trusses. This is an effective way in which to stiffen a building against wind, provided that the connections are carefully studied, and made strong enough properly to fulfill their respective functions. Fig. 49 illustrates the general scheme.

For buildings of small height and truss spans, sufficient stiffness may be obtained by trussing the roof

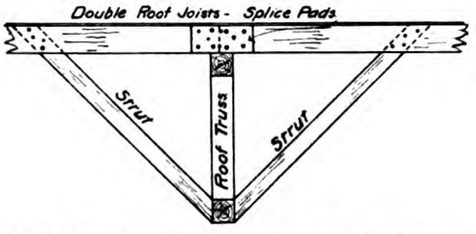

FIG. 50. METHOD OF TRUSSING ROOF JOISTS.

joists, similar to the detail shown in Fig. 50. A detail of a bracing-truss which is easily framed and is efficient is shown in Fig. 51.

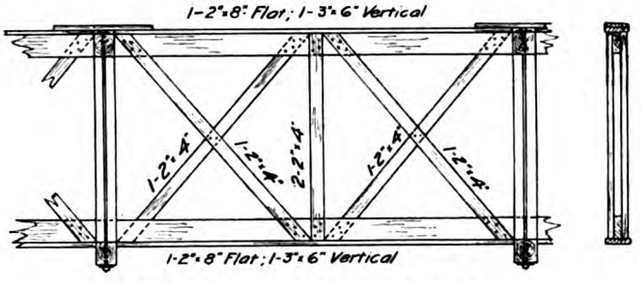

FIG. 51. DETAIL OF BRACING-TRUSS.

The requirements of bracing in timber-framed buildings are no different from those of steel-framed buildings. The general conditions of provision for wind pressure, arrangement of main trusses and bracing-trusses are the same in either type of building, with due allowance for the nature of the roof to be supported. In this connection, the excellent texts of Ketchum and Tyrell on the subject may be profitably studied by the reader interested in the construction of mill buildings, and other buildings having large open spaces, necessitating long columns and roof trusses. As was remarked in the introductory article, steel-framed buildings of these types are generally designed by a competent engineer. The same building, however, if framed in timber, is often planned by an architect unacquainted with the funda-

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mental principles of structural engineering. That the consideration of roof bracing is vital will be appreciated by reading the account of two recent failures of timber buildings, one in Salt Lake and the other in Atlanta, Georgia.[5] The last-named failure resulted in loss of life. It is significant that in both cases definite information as to the plans of the buildings, as well as accounts of the failure, were hard to obtain, there being an evident desire on the part of both the architect and the municipal authorities to hush up the matter.

A subsequent article will consider the general conditions affecting the stiffness of timber framed buildings of the mill building type, the question as to what constitutes a proper allowance for wind pressure, the best method of providing for this wind pressure, illustrating the discussion with typical examples.

LOADING OF BRIDGE FLOORS

The Highway Department of the State of Ohio has recently conducted a series of tests to determine the stress distribution of concentrated loads on bridge floors. The object of the tests, as stated in a report made by the department, was to obtain sufficient information regarding the distribution of loads through and by concrete floor slabs to enable the designer to proportion the joists of a slab floor, and the slab itself, to carry concentrated loads. Except the dead loads practically all heavy loads on highway bridge floors are concentrated on small areas. There are, therefore, in the design of reinforced concrete floors, two assumptions to be made.

1. Regarding the distribution of a concentrated load on the slab between the joist immediately below it and other joists.

2. Regarding the width of slab to be considered as carrying a concentrated load resting upon it.

A satisfactory theoretical solution of these questions is impossible, as it involves the elastic properties of both concrete and steel in flat slabs and beams with multiple supports, and requires so many assumptions that any results thus obtained would be little better than assuming the distribution at once.

The following conclusions regarding the distribution of concentrated loads on a reinforced concrete slab, to the floor joists, have been deduced from the tests:

1. The proportion of reinforcement has little or no effect upon the load distribution to the joists, as long as safe loads on the slab are not exceeded.

2. The amount of load distributed by the slab to other joists than the one immediately under the load, increases with the thickness of the slab.

3. The outside joists should be designed for the same total live load as the intermediate joists.

4. The axle load of a truck may be considered as distributed uniformly over 12 ft. in width of roadway.

5. If the slab has ample grip on the upper flanges of the I-beam, and is continuous over the floor beams, and the joists are riveted to the web of the floor beams, the live load stress in the joist may be but one-half as great as for a similar load on the bare I-beam supported at its ends.

6. Under these favorable conditions the axle load in a panel of not more than 20 ft. may be assumed as uniformly distributed over two-thirds of the length of the joists provided that they are considered as simple I-beams supported at the ends. Without these conditions, the load may be assumed as uniformly distributed over a length of at least five feet.

The effective width of a slab is that width used in designing over which a single concentrated load may be considered as uniformly distributed on a line through the middle of the slab parallel to the supports.

The tests of slabs resulted in the following conclusions:

1. The effective width is affected but little by the proportion of reinforcement parallel to the supports.

2. The effective width decreases somewhat as the load increases.

3. The effective width in relation to the span, decreases as the span increases.

4. The following formula will give a safe value of effective width where the total width of slab is greater than $1\frac{1}{3}S + 4$ feet.

$e = 0.6\,S + 1.7$ feet.

Where e is effective width in feet and S is the span in feet.

[5] See *Engineering News*, Vol. 75.

COST OF CONSTRUCTION OF CLASS A BUILDINGS

According to the *Contract Record* a careful record on the structural work of numerous first-class office buildings has been kept by F. W. Fitzpatrick, a consulting architect at Washington, D. C., who gives the following average costs per cubic foot of building.

Foundations	$0.0175
Steel framing	0.025
Granite and other masonry	0.1117
Cornice, roofs and skylights	0.0066
Fireproof floors	0.0067
Partitions (tile)	0.004
Plastering and stucco	0.015
Elevator fronts and ornamental metal work	0.02
Marble work	0.0317
Hardware	0.0013
Joiner work	0.0117
Glass	0.0041
Painting and varnishing	0.0023
Electric wiring	0.0067
Heating	0.0112
Plumbing	0.005
Elevators	0.01
Stairs, scenic structural framing 'making ends meet,' lamp fixtures, etc. What might be called a fair amount for contingencies in such a building, including lesser items not mentioned here, but grouped together	0.0419
Architect's fee	0.026
Total	$0.3594

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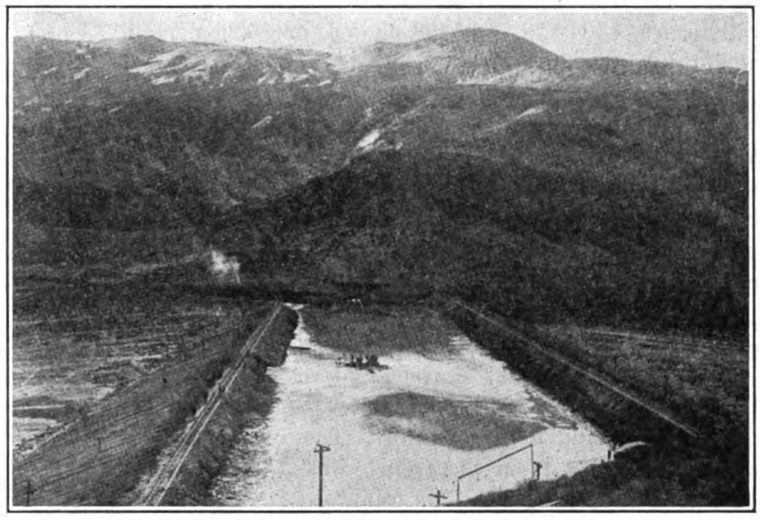
Unit Costs and Methods of Construction of Los Angeles Aqueduct

The following information is taken from the final report of the Board of Public Service Commissioners of the City of Los Angeles on the construction of the Los Angeles Aqueduct.

Transportation. The question of transportation of material was an important one, particularly for that part of the work from Mojave north, which at the commencement of the project was not served directly by any railroad. Bids were called for in December 1907 for freighting on this part of the work, and the lowest bid was $0.28 per ton-mile. An investigation was made of the cost of the construction of a railroad to be built by the city and dismantled at the completion of the work, and also of the cost of transportation over a new line from Mojave to be built and operated by the Southern Pacific Co. The estimated cost of construction of the proposed city line from Mojave to Olancha, 100 miles, using light 50-lb. rails, was $1,390,000 with a salvage value of $350,000. Allowing for interest, operating expenses, etc., the net cost of transporting freight was estimated at $1,634,237. The Southern Pacific Co. proposed to construct a railroad between the same points but by a more circuitous route, making a total distance of 118 miles, and submitted schedules of freight rates to be charged. From these it was estimated that allowing for the cost of construction and operation of a short railroad in Red Rock canyon, and for distribution of freight along the portion of the Aqueduct situated at a distance from the proposed line, there would be a saving of over $600,000 by accepting the Southern Pacific Co. proposition. This saving was further increased by obtaining better freight rates through routing all freight where possible over Southern Pacific Co. lines. The estimated cost of transportation over the proposed city line was $0.10 per ton-mile, and over the Southern Pacific Co. line was $0.045 per ton-mile. The Southern Pacific Co. line was built and now forms a link in a through line between Hazen, Nevada, and Los Angeles.

To carry freight destined for 15 miles of the Freeman division and the northern part of the Jawbone division, the city built a temporary railroad from Cantil, 23 miles north-east of Mojave, up Red Rock canyon a distance of 9 miles. This road was operated from January 1909 to December 1910, when it was dismantled and the equipment sold for about $40,000. The net cost to the city, including $15,000 for repairs, was $96,810. The average grade was 3.4%, and the most of operation was $0.08 per ton-mile. The total cost of hauling freight was $0.337 per ton-mile, including $0.203 per ton-mile for depreciation and construction charges. On account of the sandy character of the wagon-road in the canyon it is estimated that the cost of team-hauling would have been at least $0.50 per ton-mile.

Caterpillar traction-engines were used for hauling for some time, but were abandoned later, and most of the hauling was done by the city's teams. Where the roads were level and straight enough to allow two or three wagons to be handled together, the average cost of hauling was between $0.12 and $0.15 per ton-mile. In the mountain country, where crooked roads with heavy grades were frequent, the average cost was between $0.25 and $0.35 per ton-mile.



SOUTH HAIWEE DAM DURING CONSTRUCTION.—From *Aqueduct Report.*

Earth Dams. The North Haiwee dam is situated at the northern end of the Haiwee reservoir. It is 1890 ft. long with a maximum height of 34 ft. The maximum depth of water against the dam is 28 ft. The side slopes are 3 to 1 on the water side and 2½ to 1 on the land side. The depth to bedrock at this point is 120 ft. On account of the great cost of constructing a cut-off wall to bedrock, and because of the comparatively small head of water against the dam, it was decided to construct only a shallow cut-off trench.

Part of the fill was made with steam-shovels and wagons, but most of the work was done by the hydraulic-fill method. The water of Cottonwood creek was run through the completed portion of the Aqueduct to the dam-site, at which point a jetting pump, working at 100 lb. per sq. in. was used to force it through hydraulic giants against an earth bank. The muddy water was run to a concrete sump, 10 ft. in diameter, from which it was pumped through a 12-in. pipe to the dam. The jetting pump was of the centrifugal type, with a 10-in. suction,

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and was operated by a 100-hp. motor. The mud pump was also centrifugal, had a 12-in. suction and was operated by two 100-hp. motors. In order to deliver material at the far end of the line, a 10-in. centrifugal 'booster' pump was placed about half-way on the force main. The muddy water was delivered near the outer slopes, a few men with shovels being all that was needed to keep the stream turned toward the centre of the dam.

The first pit opened contained so much sand that the wear on the pumps and force main was high. The material was also such that the water could not carry a large proportion of suspended matter. For these reasons, another pit was opened. In October 1912, 5000 cu. yd. was moved from the first pit at a cost of $0.213 per cu. yd. for field expense, while during the following month, with the same equipment, 48,000 cu. yd. was moved from the second pit at a cost of $0.084 per cu. yd. The following general costs are given, exclusive of 'auxiliary charges,' which amounted to 32½% for this part of the work. The cost of test shafts was $1935.68; of core-wall trench, $1342.28 for 5158 cu. yd. or $0.26 per cu. yd.; of dry fill, $7185.82 for 26,137 cu. yd., or $0.274 per cu. yd.; of installing hydraulic machinery, $4281.21, and of sluicing, $17,421.95, distributed over 141,235 cu. yd. material, thus giving a unit cost of $0.153 per cu. yd. A concrete face containing 3215 cu. yd. was placed on the dam at a cost of $17,323.16, or $5.39 per cu. yd. The cost of engineering for the dam was $208.04, making a total of $49,698 for direct field charges.

The South Haiwee dam was 1500 ft. long with a maximum height of 75 ft. The slopes were 2½ to 1 on each side. On account of the character of the foundation, a cut-off wall, 16 ft. wide at the top, was carried to bed-rock at a maximum depth of 120 ft. The total amount of material removed from the trench was 27,302 cu. yd., the cost of excavation being as follows:

Labor	$22,422
Supplies and materials	1,843
Live-stock	2,280
Electric power	957
Freight	630
Total	$28,132

or $1.04 per cubic yard.

The cost of timbering was as follows:

Labor	$15,144
Live-stock	457
Materials and miscellaneous	25,946
Total	$41,547

or $1.53 per cu. yd., a total of $2.57.

The clay for filling the trench was loaded into dump wagons with an electric-shovel, hauled an average distance of 1000 ft., and dumped at the edge of the trench, where it was pushed into the trench with a road-grader. The trench was kept as full of water as possible.

It had been intended to construct the dam by the hydraulic-fill method, but the water-supply was insufficient and the available material contained too many boulders for the best results. A Marion steam-shovel with a 2½-yd. bucket was used to excavate the material, which was then transported about 1000 ft. to the dam-site on a 3-ft. gauge belt-line railroad. Three trains were operated, each with an 18-ton steam locomotive and seven 4-yd. dump-cars. From pit measurements it was computed that the cars actually hauled three yards of compact material. The grade was 3% against the load for the full trains and 6% with the load for the empty trains. Two 8-hour shifts were worked, the day shift usually handling about 50% more material than the night shift. The best day's run was 700 cars of material, and the average from 400 to 500. Tracks were laid on two sides of the dam. When one side had been built up as far as possible, the trains were shifted to the other side and the track elevated while the fill on the other side was being raised. Water was brought from Haiwee and Hogback creeks and discharged into the pool formed between the two fills. A 6-in. centrifugal pump operated by a 30-hp. motor was mounted on a steel hull floating in the pools. The pump supplied water to a 2-in. nozzle which was directed against the sides of the fills, washing the finer material toward the centre, thus obtaining the principal advantage of the hydraulic process.

The up-stream face of the dam was paved with 2 ft. of rip-rap, which was obtained from basalt cliffs about 1½ miles from the dam-site. After the fill had been made, the tracks were laid to the cliffs and the rock transported to the dam. The blocks were in such a shape that no quarrying was necessary except loading the cars.

The total unit costs were as follows:

	Quantity, cu. yd.	Cost	Cost per cu. yd.
Preliminary work, test pits, building railroads, etc.		$29,705.91	
Core-wall excavation	27,032	28,132.00	$1.04
Core-wall timbers	27,032	41,547.00	1.53
Core-wall puddle fill	25,000	7,170.02	0.29
Main fill	598,747	148,870.15	0.248
Paving, rip-rap	16,110	11,268.14	0.70
Engineering		1,401.95	
Total		$268,095.17	

A concrete gate-tower 14 ft. in diameter and 80 ft. high was constructed. The cost was as follows:

Gates	$7,630.83
Steel in tower	972.23
Concrete (726 cu. yd.)	6,236.06
Forms	380.78
Excavation	137.35
	$15,357.25

Auxiliary charges of 32½% should be added to the cost of both the dam and the gate-tower.

The Dry Canyon dam is near the mouth of San Francisquito canyon, about five miles from where the Aqueduct crosses the Southern Pacific railroad near Saugus. It is an earth fill 528 ft. long, with a maximum height of 61 ft. and slopes of 2½ to 1 on each side. There is a clay cut-off wall extending to bedrock 70 ft. below the original surface.

The cut-off trench was excavated in the following

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manner. A shaft was sunk in the rock at the east abutment to the level of the lowest bedrock in the centre of the canyon. A drift was run in the rock from the bottom of this shaft along the axis of the dam to the water-bearing gravel. At the end of the drift and along its roof, perforated 2-in. pipes were driven diagonally upward to the water-bearing area. The water which was drained into the shaft by this method was removed with a 5-in. centrifugal pump. The trench was then excavated from the surface and extended downward as the water-level receded. The material was shoveled into buckets and hoisted to the surface. After completing the excavation, the trench was filled with water. Clay was excavated from a bank nearby, with steam-shovels, and hauled to the edge of the trench with wagons. It was pushed into the trench with a road-surfacing machine.

A steam-shovel, loading material on wagons, was used to build the toes of the main dam. A pond was formed between the two toes, into which water carrying clay material excavated by the hydraulic method was discharged. This gave dense fine material toward the centre of the dam.

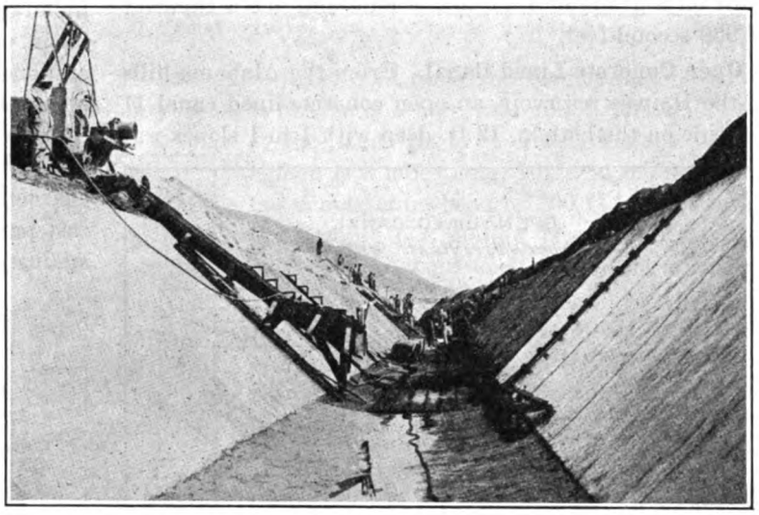
The cost of constructing the dam is summarized as follows:

	Quantity, cu yd.	Cost	Cost per cu. yd.
Core-wall trench:			
Excavation and timbering	5,350	$21,710.32	$4.06
Puddle fill	5,350	3,902.62	0.73
Hydraulic fill	45,610	8,038.36	0.176
Dry fill	95,390	25,207.55	0.26
Engineering and supervision		2,490.79	
Concrete spillway	146	860.72	5.98
Spillway excavation		854.02	
Concrete outlet gates	293	2,014.31	6.86
Concrete surfacing on upper slope	470	1,385.47	2.95
Drain pipe		5,290.89	
Oil surfacing on slopes		1,224.35	
Outlet gates		3,377.35	
Miscellaneous		2,374.82	
Total		$78,731.57	

To this amount should be added an estimated loss of $1941.27 because of a flood which washed away a portion of the fill, making a total cost of $80,672.84. The 'auxiliary charges' which should be added to this amount are not stated.

Tunnels. There were 164 tunnels on the Aqueduct, the longest, the Elizabeth, being five miles long. The bonus system in force was an important factor affecting the cost of construction. A base rate of progress was fixed for each tunnel, and bonuses were paid to the men actually engaged in driving the tunnel for each ten-day period where the progress exceeded the base rate. Provisions were made so that the men did not suffer because of sickness, shut-downs, or other matters not within their control. The base rate of progress and the bonus varied with the character of the work in each tunnel.

For the Elizabeth tunnel, which was in hard rock, the base rate was 8 ft. per day, or 2⅔ ft. per shift, requiring 4.18 cu. yd. excavation per lin. ft. in the untimbered tunnel, and 6 ft. per day, or 2 ft. per shift, requiring 5.02 cu. yd. excavation and placing 115 ft. B.M. lumber per lin. ft. in the timbered tunnel. The base wage was $3 per shift for miners and timber-men and $2.50 for shovelers, with an extra $0.50 per day in wet tunnels. In the Elizabeth tunnel each man was paid $0.40 per foot for each additional foot over the base rate. The average progress for the entire tunnel was 10.8 ft. per day in each heading. The average cost per lin. ft. was as follows:



PLACING CONCRETE ON OPEN LINED CANAL.—From *Aqueduct Report.*

Excavation, including timbering	$41.35
Lining	9.65
Local administration and superintendence	2.10
Equipment	7.92
Buildings, water-supply, etc	5.83
Engineering	1.00
Total	$67.85

To this should be added 3.55%, or $2.35 per ft. for general administration, making a total of $70.20 per foot.

In November 1909, the tunnel work on the Aqueduct was in full swing. During this month, 9131 lin. ft. of tunnel was excavated, of which 4033 ft. was excess footage, showing an increase in speed of 72%. Ninety per cent of the crews earned bonuses ranging from $0.12 to $1.95 per man per day. The average cost per foot of tunnel for labor, including bonus, was $9.87, while if the base rate of progress had been made without bonus, the cost would have been $13.80.

Open Unlined Canal. From the intake on Owens river, to the north end of the Alabama hills, a distance of 23 miles, the Aqueduct is an unlined earth canal, 38 ft. wide on the bottom and running water 7 ft. deep. The average excavation was 15 cu. yd. per lin. ft. This part of the work was done with electrically-operated floating dredges. Two suction dredges were used at

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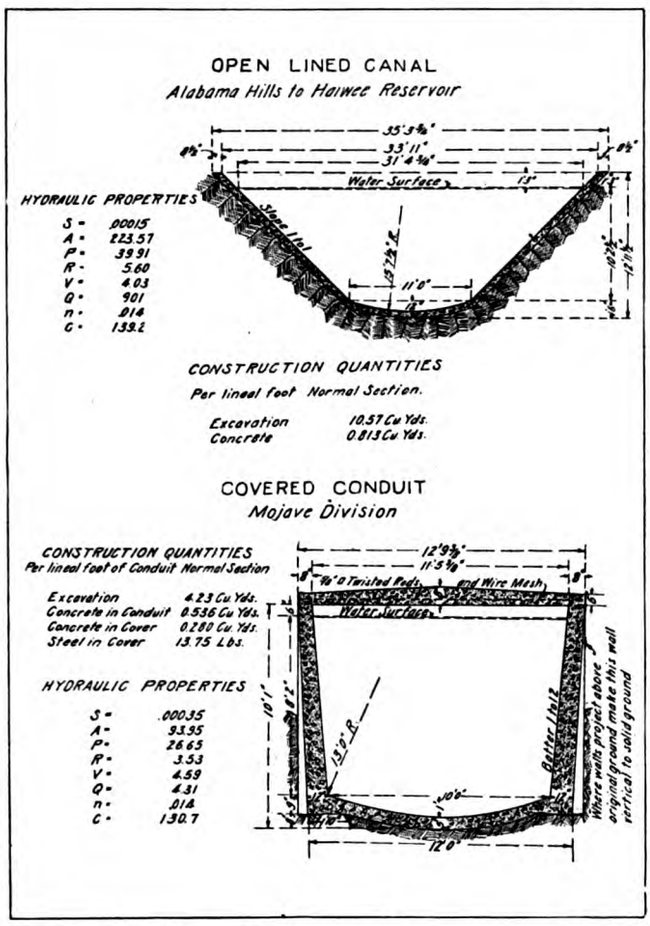
first, but these were replaced later by a dipper dredge. The suction dredges excavated 41,540 lin. ft. of canal at an average cost of $3.09 per lin. ft. for direct charges. The dipper dredge excavated 70,000 lin. ft. at an average cost of $0.81 per lin. ft. This part of the Aqueduct is built on a grade of 1 ft. to the mile and has a capacity of 900 second-feet.

Open Concrete-Lined Canal. From the Alabama hills to the Haiwee reservoir, an open concrete-lined canal 11 ft. wide on the bottom, 12 ft. deep with 1 to 1 slopes was

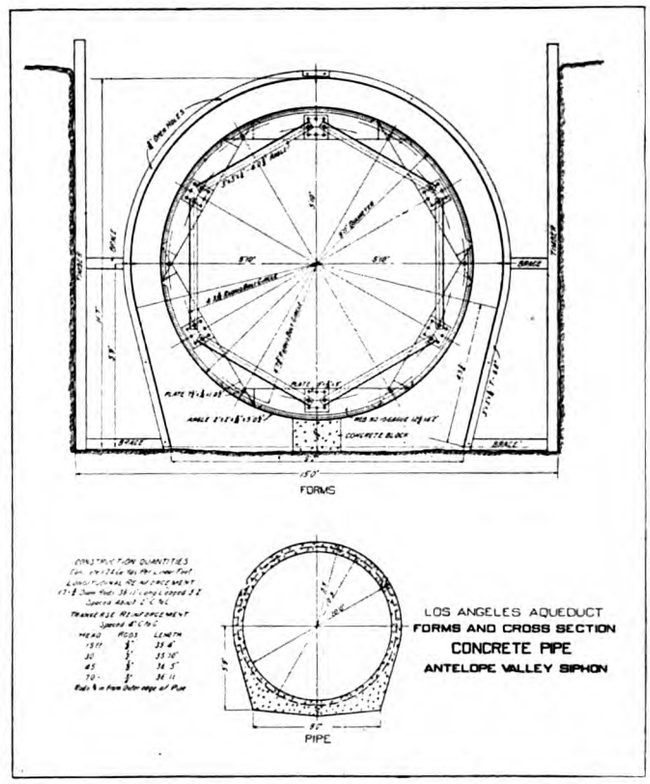


OPEN AND COVERED CANAL SECTIONS.—From *Aqueduct Report.*

used. The grade was 0.00015 and the capacity 900 second-feet. The excavation required ranged from 8½ to 30 cu. yd. per lin. ft., according to the slope of the ground surface and the concrete was 0.813 cu. yd. per lin. ft. Loose desert soil cost about $0.10 per cu. yd. to excavate with steam or electric-shovels. Where boulders up to 5 ft. in diameter, some of them in cemented gravel, were encountered, the average cost with steam-shovels was $0.18 per cu. yd. Where electric-shovels were used in this material considerable blasting was necessary, bringing the cost up to $0.28 per cu. yd. The average cost per foot of conduit was $8.38 for direct charges, and $11.15 including auxiliary charges.

Closed Concrete-Lined Canal. From the Haiwee reservoir to the Fairmount reservoir, the standard section is a closed concrete-lined conduit with nearly vertical sides and approximately 10½ by 12½ ft., having a capacity of 430 second-feet. This work was done with ¾-yd. Marion steam-shovels with 25-ft. booms. The field cost of excavation varied from $0.08 to $0.10 per cu. yd. in the light desert soils to $0.35 to $0.45 in rock.

Inverted Siphons of Steel Pipe. A bonus system was in force for the riveting on all the siphons done by day labor, with the exception of the Jawbone Canyon siphon and one of those in Nine Mile canyon. The effect of this bonus on the cost of riveting is shown by a comparison of costs during the month of December, 1912, on the Pine Canyon and Jawbone Canyon siphons. The general character of the work was similar, but the average labor cost per rivet for the Jawbone Canyon siphon was 5⅔c. against 3⅓c. for the Pine Canyon siphon. Most of the



CONCRETE INVERTED SIPHONS.—From *Aqueduct Report.*

rivets on both siphons were ⅝ in., with a few ¾, ⅞, and 1 in. The Pine Canyon riveters earned $1.50 per day bonus on an average.

The Jawbone siphon operates under a maximum head of 850 ft., the greatest of any on the Aqueduct. It is 7096 ft. long and ranges from 7 ft. 6 in. to 10 ft. in diameter. The plates range from ¼ to 1⅛ in. thick. The pipe cost 1.4857c. per lb. f.o.b., Pittsburg, Pennsylvania. It was shipped by rail to Cinco and hauled 4 miles to the site with teams. The sections of pipe were placed on the hillsides by a rope tramway operated by a motor-driven hoist. The pipe was set on concrete piers, 2 ft. thick extending one-fourth of the lower circumference of the pipe and 3 ft. broader than the diameter of the pipe. The piers extended to bedrock on the hillsides, and 8 ft. into the gravel in the bottom of the canyon. They were spaced 36 ft. centre to centre across the bottom of the

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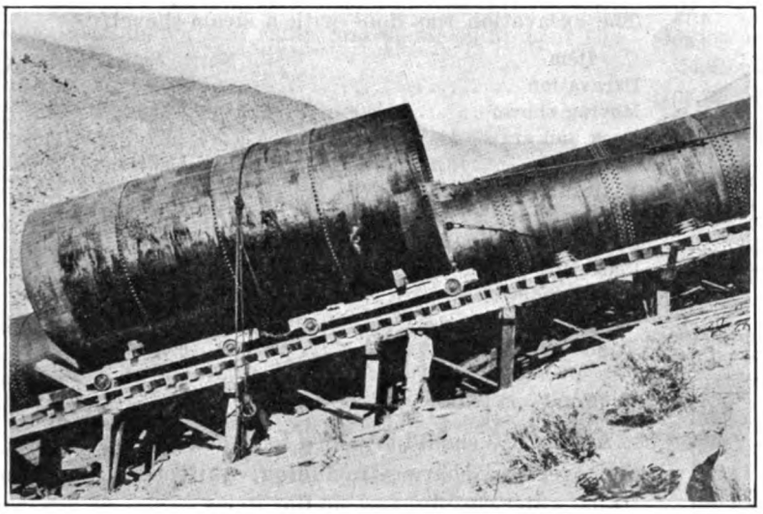
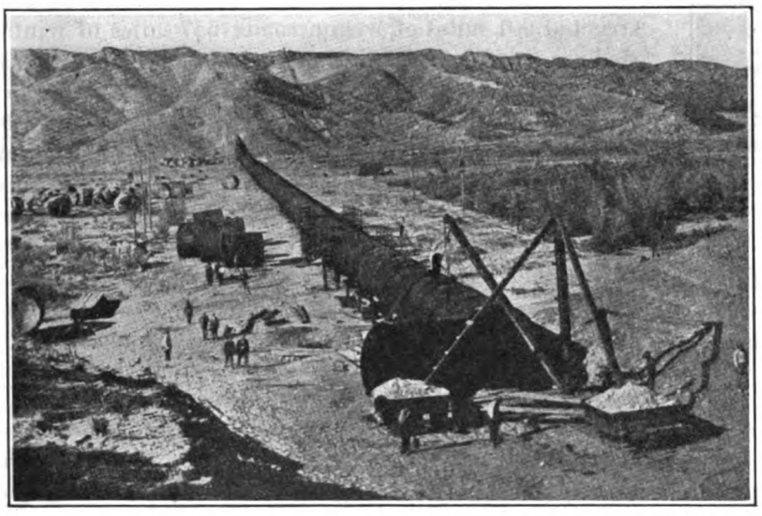
canyon and were placed proportionately closer together on the hillsides.

The detail unit costs up to January 31, 1913, when the siphon was practically completed, are as follows:

	Piers	Each	Per cu. yd.
Excavation	163	$23.41	$0.50
Concrete	187	59.08	8.57
Forms	187	3.79	0.55
Average cost per pier			$86.28
Concrete, per cubic yard			9.12



TRAMWAY FOR HANDLING PIPE ON JAWBONE CANYON SIPHON.
From *Aqueduct Report.*



SOLEDAD CANYON SIPHON.—From *Aqueduct Report.*

Average cost for trenching, per foot of siphon		0.65
Average cost per foot of siphon for piers and trench excavation		2.83

COST OF PIPE

Item	Per foot of siphon	Per 100 lb.
Steel f.o.b. Cinco	$21.80	$2.57
Unloading and hauling	1.42	0.17
Placing	2.45	0.29
Riveting	2.52	0.30
Caulking	0.90	0.11
Painting	0.65	0.08
Equipment	3.66	0.43
Superintendence	0.37	0.04
Engineering	0.17	0.02
Blow-offs	0.06	0.01
Total	$34.00	$4.02

These are direct field costs and do not include auxiliary charges for roads, water, and minor details.

The steel part of the Antelope Valley siphon is 3 miles long, 10 ft. in diameter and has a maximum head of 200 ft. It is laid on the ground in a shallow trench and the pipe backfilled to about one-third of the diameter. The steel cost 1.5c. per lb. f.o.b., Leetsdale, Pennsylvania. It was shipped by rail to Mojave and hauled 35 miles over nearly level roads to the site. Following are the detailed unit costs for work, on the steel pipe:

Item	Per foot of siphon	Per 100 lb.
Steel rolled and punched, f.o.b. Mojave	$9.84	$2.30
Handling and hauling	1.46	0.43
Placing	0.52	0.12
Riveting	1.19	0.28
Caulking	0.24	0.06
Painting	0.15	0.04
Equipment	0.87	0.21
Superintendence	0.11	0.03
Engineering	0.04	0.01
Backfill	0.19	....
Bell-holes	0.11	....
Dismantling camp	0.01	....
Manholes	0.01	....
Blow-off valves	0.03	....
Total	$15.58	$3.39

Trench excavation cost $0.33 per lin. ft. of siphon, and anchorages, $0.48 per ft. Auxiliary and overhead charges of 10% should be added to the above costs.

A summary of data regarding the steel siphons appears on page 430. The costs are for the steel pipe in place, not including excavation, piers, or transition structures. It is not clear why the costs given for the Jawbone Canyon and Antelope Valley siphons do not check with the detail statements.

Steel for the Nine-Mile siphon cost 1.9733c. per lb., f.o.b. Camden, New Jersey. Steel for the No Name, Deadman, Soledad, Quigley, and Placerita siphons cost 1.6983c. per lb., f.o.b. Midland, Pennsylvania. Steel for the Sand Canyon, Grapevine, Jawbone, Pine Canyon, and Antelope siphons cost 1.4857c. per lb., f.o.b. Pittsburg, Pennsylvania.

In addition to the above work by city forces, the Dove Springs and San Antonio siphons were constructed by contract at a total cost to the city of $30,423 or $5.83 per 100 pounds.

Inverted Siphons of Concrete. For heads up to 75

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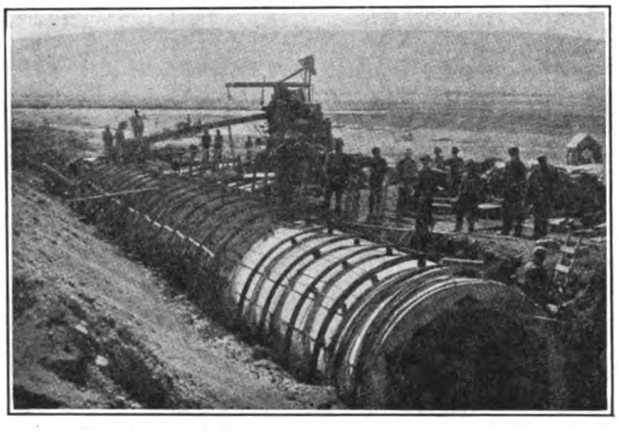
Siphon	Length, ft.	Diam., ft.	Plate, in.	Weight, tons	Total cost	Cost per 100 lb.
Nine-Mile	1,415	9½	¼–$\frac{5}{16}$	252.75	$26,456	$5.63
No Name	2,016	9½	¼–$\frac{5}{16}$	481.50	44,249	4.60
Sand Canyon	890	8½	$\frac{11}{16}$	428.29	34,590	4.03
Jawbone	8,095	7½–10	¼–1⅛	3,216.51	265,065	4.10
Grapevine	2,339	9½	¼–$\frac{9}{16}$	651.16	52,926	4.07
Pine Canyon	3,841	9	¼–¾	1,508.51	110,130	3.66
Antelope	15,597	10	¼–⅜	3,511.63	231,902	3.30
Deadman	3,430	11	¼–½	1,071.07	80,150	3.75
Soledad	8,041	10–11	¼–½	2,274.47	172,151	3.80
Quigley	612	11	¼	116.74	9,629	4.13
Placerita	1,572	11	¼	313.72	27,097	4.30
Total	47,848			13,826.36	$1,056,353	$3.80

ft. reinforced concrete pipe was used instead of riveted steel. These siphons were all 10 ft. in diameter and were buried in trenches. A 1:2:4 mixture was used. The quantity of concrete required was 1.24 cu. yd. per lin. ft. Superintendents were paid $250 per month, foremen, $4 per day, and laborers, $2.50.

The Whitney siphon is in a canyon near Saugus on the



PLACING CONCRETE ON ANTELOPE SIPHON.
From *Aqueduct Report.*

Southern Pacific Railroad. It is 955 ft. long. The sides of the canyon have a slope of about 1 vertical to 3 horizontal. Excavation on the side-hill was done by hand on the flat by teams. The detailed costs were as follows:

	Per lin. ft.
Excavation	$5.48
Concrete pipe	8.33
Steel	3.83
Back-fill	2.64
Anchorages	0.14
Blow-off	1.29
Engineering	0.13
Total	$21.84

The following items are included in the cost of concrete: forms, $1.20 per lin. ft.; mixing and placing concrete, $2.88 per cu. yd. Placing steel cost $0.83 per ft. It is not clear whether this latter amount is included under concrete pipe or under steel in the detailed statement. Cement cost $1.65 per bbl. on the job, and gravel $0.90 per cu. yd. While not expressly stated, it is supposed that these are field costs and that auxiliary charges are to be added.

Concrete pipe was used at both ends of the Antelope Valley siphon, where the head did not exceed 80 ft. There was 6197 ft. of concrete pipe in all, 2750 ft. on the north end and 3447 ft. on the south end. Tufa cement was used from the Fairmount plant, the haul being 22 miles, and the cost of hauling $0.12 per ton-mile. An average of 1.48 cu. yd. concrete per lin. ft. of siphon was placed on the north end and 1.3 cu. yd. on the south end. The excavation was done with a steam-shovel.

Item	North End	South End
Excavation	$0.59	$0.94
Moving shovel	0.05	....
Rock and gravel for concrete	1.85	3.68
Cement	6.25	5.80
Mixing and placing concrete	0.96	0.91
Setting forms	0.55	0.62
Steel, including labor placing	4.00	4.30
Plastering	0.70	0.26
Superintendence	0.17	0.26
Back-filling	0.33	0.39
Engineering	0.03	0.04
Total	$15.48	$17.20

About 20% should be added to these costs for auxiliary and overhead charges, including equipment, roads and trails, water-supply, and similar items.

HIGHWAYS IN ALASKA

Since 1906 the Alaska Road Commission has constructed 901 miles of wagon roads, 557 miles of winter sled-roads, and 2216 miles of trails. The average cost of construction of the wagon roads has been $3000 per mile, of the sled roads, $325 per mile, and of the trails, $100 per mile. The practical value of this road construction is shown by the fact that the cost of transporting freight over the Government-built and maintained roads in 1912, was $1,243,735, while it is estimated that without these roads the cost of this work would have been $3,385,412, a saving in one year of $2,141,677, or approximately the total amount spent by the Federal Government in the construction of the entire road and trail system of the Territory.

Adding machines are being used by several of the level parties of the U. S. Coast and Geodetic Survey. The machine is strapped to the top of a motor velocipede on which the party goes to and from the working ground. The leveling is done along railroads, and the car is moved forward with the observer as the work progresses. Recording can be done more quickly and with less likelihood of errors than when the recorder used the old method of entering the observations in a record book. The back-sights and fore-sights are recorded separately by the machine in parallel columns. The machine is of the listing type, so that it gives a permanent record of the observations. The saving of time and money in a single season will more than pay for the cost of the machine.

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Cost of Highway Construction in Gila County, Arizona

The following figures are taken from a progress report by County Engineer Thomas, published in the Globe *Arizona Record.* It is stated that the costs include prorated office and miscellaneous expenses, and equipment depreciation, in fact, all overhead expense. Beside surveying instruments and camp and small equipment the county owns the following:

1 roadster automobile.	10 plows.
1 automobile truck.	25 fresno scrapers.
1 concrete mixer.	10 slip scrapers.
12 road drags.	9 wheel scrapers.

A minimum wage of $3.50 per day is paid and the men are charged $1 per day for board. Below follows the camp and mess-house statement for the six months from February 1 to August 1, 1916:

	Dr.	Cr.	Cost per day per man	Distance from Globe, miles
Red Hill to Scott's	$1,436.24	$1,625.10	$0.8837	55
Scott's to Packard	1,046.99	1,071.93	0.9753	61
Wooton's	476.16	428.00	1.1125	52
Tonto Hill to Hardt's	998.72	947.50	1.0550	72
Ash Creek	893.19	666.95	1.3399	100
Pine Summit	2,119.62	2,386.90	0.85	114
Russell Gulch	246.66	241.75	1.02	12
Miami-Gibson	850.11	741.60	1.15559	10
	$8,067.69	$8,109.73		
Profit		42.04		
	$8,067.69	$8,067.69		

Cost of feeding stock is summarized as follows:

	Number of mule days	Cost	Cost per mule day
Globe-Miami	1,984	$1,044.90	$0.53
Copper Hill	787	429.45	0.54
Red Hill, Scott's, Wooton's, and Tonto Hill	2,985	1,935.86	0.65
Pine Summit and Ash Creek	1,988	1,561.60	0.79
Total	7,744	$4,971.81	$0.62

Following is the cost of construction of 0.75 mile of highway in the Ash Creek section, 100 miles from Globe:

Engineering		$ 304.65
Clearing and grubbing, 66.4 acres at $45.53		291.39
Earth, 1,800.5 cu. yd. at $0.4095		737.34
Loose rock, 1,251.7 cu. yd. at $1.194		1,494.12
Solid rock, 1,031.2 cu. yd. at $2.293		2,364.11
Head-walls, 6.5 cu. yd. at $5.873		32.30
Hauling and laying pipe, 156 ft. at $1.81		282.33
Cost of pipe f.o.b. Globe:		
76 ft. of 24-in. at $1.85	$140.60	
40 ft. of 30-in. at $2.709	108.36	
40 ft. of 36-in. at $3.27	130.80	
		379.76
Total		$5,886.00

This being the first section of the work done north of Payson the overhead expense was greater than the other work in this part of the country, due to moving camp from Gold Gulch to Ash Creek, a distance of 28 miles, over heavy grades, costing $400. Several heavy rock ledges were encountered in this section. The cuts were shallow and costs correspondingly high.

Following is the cost of construction of about 19,000 lin. ft. of highway, at Pine Summit, 114 miles from Globe, the work being done in June and July.

Engineering		$ 568.22
Clearing and grubbing, 12.1 acres at $76.67		924.64
Earth, 4,851.7 cu. yd at $0.4021		1,950.87
Loose rock, 5,958.2 cu. yd. at $0.6371		3,796.11
Solid rock, 1,588.4 cu. yd. at $1.335		2,120.51
Ditching, 700 lin. ft. at $0.1532		107.54
Rip-rap, 146.22 cu. yd. at $2.24		327.30
Hauling and laying pipe, 308 lin. ft. at $1.992		369.35
Cost of pipe f.o.b. Globe:		
20 ft. of 18-in. at $1.378	$ 27.56	
124 ft. of 24-in. at $1.85	236.80	
40 ft. of 30-in. at $2.7009	108.36	
80 ft. of 36-in. at $3.27	261.60	
40 ft. of 48-in. at $4.872	194.88	
		829.20
Total		$10,993.74

This work was done in the heavy pine forest between Payson and Pine. The material shows more rock than any work previously encountered in this section. Basalt boulders predominate, and the work was extremely heavy for both stock and equipment. It was necessary to do a good deal of blasting in making the surface ditches.

Following is the cost of about 9700 lin. ft. of highway at Gold Gulch, the work being done in May.

Engineering		$ 395.27
Cleaning and grubbing, 13.315 acres at $35.806		476.75
Earth, 8704 cu. yd. at $0.511		4,478.80
Masonry walls, 24.9 cu. yd. at $7.675		191.11
Surface ditches, 1145 lin. ft. at $0.0551		63.10
Handling and laying pipe, 290 lin. ft. at $0.9822		284.85
Cost of pipe f.o.b. Globe:		
112 ft. of 24-in. at $1.85	$207.20	
88 ft. of 30-in. at $2.709	238.39	
60 ft. of 36-in. at $3.27	196.20	
30 ft. of 48-in. at $4.872	146.16	
		787.95
Total		$6,677.83

The material was a heavy red clay containing a large proportion of gravel and boulders. Heavy lime deposits were encountered, all of which necessitated much shooting. Camp was moved from Wooton's, a distance of about 22 miles.

Following is the cost of about 2600 ft. of highway at Copper hill.

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Engineering		$ 211.91
Clearing and grubbing, 1.65 acres at $88.62		146.22
Earth, 3684 cu. yd. at $1.071		3,956.85
Surface ditch, 440 lin. ft. at $0.082		36.00
Headwalls, 1: 3: 6 concrete, 18.64 cu. yd. at $19.035		354.80
Hauling pipe, 194 lin. ft.		73.05
Laying pipe, 194 lin. ft. at $0.663		128.65
Cost of pipe f.o.b. Globe:		
22 ft. of 18-in. at $1.454	$ 32.00	
58 ft. of 24-in. at $1.850	107.82	
18 ft. of 30-in. at $2.705	48.69	
96 ft. of 36-in. at $4.68	449.29	
		637.80
Total		$5,545.29

In explanation of the high unit costs on this work, it should be stated that a complete outfit had to be organized and such costs are charged to the initial job. Experienced dirt movers were unobtainable and much green labor was employed. The material was a tough clay and quartzite boulder formation. Clearing and grubbing costs include the removal from the right-of-way of houses, telephone poles, water mains, etc. The head-wall and pipe-laying costs include the excavation for the same.

Following is the cost of about 4000 ft. of highway at Wooton's, 52 miles from Globe, the work being done during May.

Clearing and grubbing, 5.4 acres at $54.75		$ 295.64
Earth, 3550.6 cu. yd. at $0.4009		1,423.87
Rip-rap, 90.6 cu. yd. at $1.669		153.20
Hauling and laying pipe, 96 ft. at $0.4661		44.75
Cost of pipe f.o.b. Globe:		
72 ft. of 24-in. at $1.378	$133.20	
24 ft. of 30-in. at $2.709	65.02	
		198.22
Total		$2,115.68

Heavy mesquite brush increased the cost of clearing and grubbing on this section. Camp was moved a distance of about 9 miles.

Following is the cost of construction of 3482 ft. of highway at Pinto creek, the work being done during June and July.

Engineering		$ 143.51
Clearing and grubbing, 2.4 acres at $87.50		210.00
Earth, 1985.5 cu. yd. at $0.5765		1,144.06
Loose rock, 2361.2 cu. yd. at $0.9727		2,296.93
Solid rock, 1016.5 cu. yd. at $1.2429		1,264.75
Rip-rap, rock wall, 66.6 cu. yd. at $6.6895		445.52
Hauling and laying pipe, 84 lin. ft. at $0.857		82.30
Cost of pipe f.o.b. Globe:		
64 lin. ft. at $1.85	$118.40	
20 lin. ft. at $2.709	54.40	
		172.80
Total		$5,759.87

This section was all side-hill work, and practically the entire job was done with pick and shovel, no part of the work being such that teams could be used. The material classified as loose rock is that known as 'Pinal schist,' and while not really a solid rock, a great deal of shooting was necessary.

Following is the cost of the section of the Globe-Payson highway between Packard's and Scott's, about 3½ miles. The distance from Globe is 60 miles. The work was done between April 1 and May 15.

Engineering		$ 288.34
Clearing and grubbing, 10.33 acres at $48.716		503.24
Earth, 114 cu. yd. at $0.43623		4,973.76
Masonry walls, 167 cu. yd. at $4.454		745.20
Bridge, 2235 ft. B.M. lumber; hauling and labor		228.63
Fencing road		116.52
Laying pipe, 338 ft. at $0.273		92.32
Cost of pipe f.o.b. Globe:		
232½ ft. of 24-in. at $1.85	$429.20	
84 ft. of 30-in. at $2.709	227.56	
22 ft. of 36-in. at $3.27	71.94	
		728.70
Total		$7,676.71

Most of the material was a heavy clay interspersed with gravel and boulders.

Following is the cost of the Red Hill section of the Globe-Payson highway, about 14,500 ft.

Engineering, 4.70%		$ 448.41
Clearing and grubbing, 12.856 acres at $34.986		449.78
Hardpan, 10,374 cu. yd. at $0.7093		7,357.87
Surface ditches, 3650 lin. ft. at $0.0513		187.29
Dry walls, 7.33 cu. yd. at $4.06		29.76
Masonry walls, 15.92 cu. yd. at $17.625		280.58
Laying pipe, 380 lin. ft. at $0.2174		82.68
Culvert pipe f.o.b. Globe:		
94 ft. of 18-in. at $1.378	$129.53	
246 ft. of 24-in. at $1.85	455.10	
20 ft. of 30-in. at $2.709	54.18	
20 ft. of 36-in. at $3.27	65.40	
		704.21
Total		$9,540.58

This was the first work done in the northern part of the county. The organization charge of assembling equipment and men and moving from Globe to the camp site, a distance of 55 miles, has been absorbed in the above costs. The old Red Hill road had been rendered impassable by unusual flood conditions, and this necessitated that construction start during the winter rainy season. It rained a great deal and, owing to the formation, a heavy red clay mixed with boulders and strata of gypsum, this proved a heavy handicap. The strata of gypsum required much blasting.

Following is the cost of reconstruction of the lower Miami highway, the work being done during June, July, and August.

Engineering		$ 411.75
Clearing and grubbing		43.06
Earth, 14,378 cu. yd. at $0.374		5,377.68
Ballast, 2840 cu. yd. at $0.925		2,625.46
Pipe cost f.o.b. Globe, 96 ft. of 48-in. and 30 ft. of 36-in.		565.81
Hauling and laying 126 lin. ft. of pipe		182.03
Removing old bridge		450.85
New bridge (not complete)		957.35
Total		$10,613.99

This highway is so situated that it could not be closed to traffic. Traffic at this point averages 2000 automobiles and other vehicles daily. This materially added to the cost.

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High-Tension Power Transmission*

By S. W. KITTLEMAN†

One of the most important changes which has been made in the design of high-tension lines is the substitution of suspension insulators for the old pin-type. The suspension insulator, as the name indicates, consists of a flexible string of insulator discs, the number depending upon the voltage, suspended from the cross-arm, thus providing a flexible support for the conductor. With this type of construction, conditions occur that do not exist when the conductor is fastened rigidly at each point of support, and these conditions must be given consideration in the design of the line.

If one conductor support is a considerable distance below a straight line connecting the adjacent points of support, up-strain is likely to result in cold weather. To provide against this a ground profile must be taken over uneven country and the poles with proper conductor-elevations indicated on the profile. Then by means of a template, representing the conductor sag for the lowest temperature likely to be experienced in the locality, the up-strain points may be determined. This is accomplished by placing the template at the points of support of the two towers adjacent to the low point. If the curve lies above the point of support of the middle tower there will be up-strain. Where up-strain points cannot be eliminated by omitting the structure the line must be dead-ended on the up-strain tower.

Another condition which occurs in a flexible line is the swinging together of conductors, when placed in a vertical plane, resulting from snow falling from a lower wire and remaining on the upper wire. The worst condition is when snow falls from the lower wire of one span and remains on the same wire of the adjacent spans, while snow remains on the upper wire of the middle span but falls from the same wire on adjacent spans. To provide against this condition, additional vertical clearance must be allowed.

Proper sagging of conductors is of the utmost importance. Copper wire is commonly used in this vicinity. The working stress is usually about one-half of its ultimate strength. For computing sag and tension curves the conductor is assumed as having the maximum allowable stress under the heaviest sleet and wind load which may arise. For this region this maximum load is taken as that produced by a $\frac{1}{4}$-in. radial thickness of ice combined with a wind velocity of 65 miles per hour acting on the increased diameter of the conductor. Probably the most convenient method of computing sags and stringing tensions is that published in the Transactions of the American Institute of Electrical Engineers, Vol. XXX, by Percy H. Thomas, under the title, 'Sag Calculations for Suspended Wires.'

A new type of conductor which is coming into use rapidly consists of a stranded copper or aluminum envelope with a steel core. This type of conductor has two advantages; it provides an increase in cross-sectional area at a less cost than if the cable were composed of all copper or aluminum strands, and it possesses greater tensile-strength. Increased cross-section tends to reduce corona losses and increased tensile strength allows less sag and consequently longer spans or shorter poles. It is necessary to first determine the mean loaded modulus of elasticity and coefficient of expansion for the composite cable in making computations for sag and stringing tensions. An article in the *Electrical World,* Vol. 66, No. 10, by E. T. Driver and E. V. Pennell, under the title 'Steel-Reinforced Aluminum Cables,' explains the method of making these calculations. In some sections, an aluminum cable with a steel core is used quite generally, but in this region aluminum is little used. There is one important line, running over the mountainous districts of southern Utah, which is of a copper cable with steel core. Frequently on a copper line where excessively long spans occur, a copper-clad cable is used on the long spans. For the same conductivity this wire is heavier than the copper and consequently the tower where the change is made must be dead-ended.

Important trunk transmission-lines are usually carried on steel towers. The type that has come into most general use is the square tower. Some towers carry a double-circuit 130,000-volt line and permit a spacing of 650 ft. in level country. Less important lines of over 100,000 volts are sometimes carried on wooden posts, two-pole construction being used with the conductors placed in a horizontal plane. It is not practical to carry two circuits of such high voltage on wood poles. For voltage around 50,000, the single pole type is used with two cross-arms for single circuit and three cross-arms for double circuit. This type of construction on single circuits, using 50-ft. poles, allows a pole spacing of from 275 to 350 ft.; and on double circuits, using 55-ft. poles, allows from 175 to 275 ft. spacing, depending upon the size of conductor. These allowable spans are based upon a clearance of 25 ft. from the ground, which is the minimum clearance which should be allowed on lines of 44,000 volts and over.

In mountainous country, it is probably advisable to run levels over the line and determine the tower positions from the plotted profile. Excessive span lengths should be avoided where practicable and for this reason a rather extensive preliminary reconnaissance is often necessary. It is advisable to avoid railroad and power-line crossings and also to avoid passing through cultivated land. Railroads require special construction on towers adjacent to tracks and also extra clearance over tracks.

*From *Journal* of Utah Society of Engineers.

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Tractive Resistance of Various Types of Road Surfaces

The results of an investigation made at the Massachusetts Institute of Technology of the tractive resistance of several kinds of roads are reported by A. E. Kennelly and O. R. Schurig in a paper presented before the American Institute of Electrical Engineers. The vehicle used was a worm-drive single-reduction electric truck having a capacity of 1000 lb. The overall length of the frame was 168½ in., the width 35 in., the wheel base, 107⅝ in., and the wheel gauge, 58 in. Solid-rubber demountable tires measuring 2½ by 36 in. were used on all four wheels. The truck was equipped with a direct-current series-motor.

Road tests were made over selected measured lengths of road at different measured truck speeds, to determine the gross battery output. Laboratory tests were made to determine the overall efficiency between battery terminals and rear-wheel treads, at speeds and loads corresponding to the road tests. The length of runs in the road tests ranged between 400 and 2600 ft. The controller was kept in the same position during each run. Runs where it was necessary to use the brakes were disregarded in preparing the data. For each controller speed the car was run three times in each direction over the test section, in this way minimizing the effect of wind resistance. There were no heavy winds during the period of the tests. In the laboratory tests the rear wheels were raised from the ground and each wheel was belted to a load-generator. The motor was then operated at different speeds corresponding to the speeds in the road tests.

The curves in Fig. 1 show the total tractive resistance for various types of road surfaces at different speeds. In Table I, the tractive resistances for different speeds and types are expressed in terms of equivalent grade.

The following conclusions regarding tractive resistance are given in the article. They apply to a solid rubber-tired motor truck operated over urban roads at speeds ranging between 8 and 15.5 miles per hour.

1. The overall efficiency of the test-truck mechanism, between battery terminals and rear-wheel treads, reached a maximum value of about 78%, under the most favorable conditions.

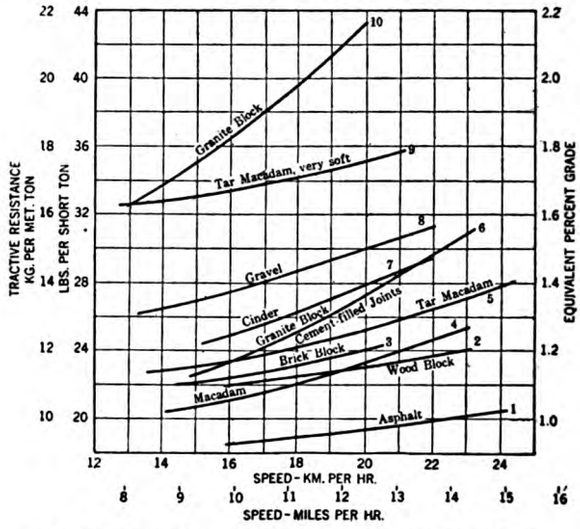

FIG. 1. TRACTIVE RESISTANCE FOR ROAD SURFACES.

2. The mechanical efficiency of transmission from motor shaft to rear-wheel treads, for the truck tested, shaft-driven through a single-reduction worm gear, was found to be as high as 90%.

3. Tractive resistances are most conveniently expressed as an equivalent grade; that is, a level road of

TABLE I. EQUIVALENT GRADES FOR TRACTIVE RESISTANCES ON DIFFERENT ROADS.

Road		Equivalent per cent grade		Per cent increase in tractive resistance from 16 to 20 km. per hr.	Comparative tractive resistance factors referred to asphalt roads	
Type	Condition	at 16 km./hr. (10 miles per hour)	at 20 km./hr. (12.4 miles per hour)		at 16 km./hr.	at 20 km./hr.
Asphalt	good	0.93	0.97	4	1.0	1.0
Asphalt	poor	1.03	1.16	11	1.11	1.20
Wood block	good	1.10	1.15	5	1.18	1.18
Brick block	good	1.12	1.21	8	1.20	1.25
Brick block	slightly worn	1.14	1.27	11	1.23	1.31
Granite block	good	1.83	2.16	18	1.97	2.23
Granite block with cement joints	good	1.16	1.37	18	1.25	1.41
Macadam, water bonded	dry and hard	1.06	1.17	10	1.14	1.20
Macadam, water bonded	fair, heavily oiled	1.63	1.76	8	1.75	1.82
Macadam, water bonded	poor, damp some holes	1.65	1.89	15	1.78	1.95
Tar macadam	good	1.17	1.27	9	1.26	1.31
Tar macadam	very soft	1.67	1.76	5	1.80	1.81
Tar macadam	many holes, extremely poor, soft	2.38	2.75	16	2.55	2.85
Cinder	fair, hard	1.25	1.39	11	1.35	1.43
Gravel	fair, dusty	1.37	1.50	9	1.47	1.55

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definite tractive resistance may be regarded as a road of zero tractive resistance, but rising uniformly x units in 100 units of road length, or having an equivalent grade of x per cent.

4. Under the conditions of these tests, the tractive resistance on level roads, in the absence of wind, is composed of (a) displacement resistance, (b) impact resistance, and (c) air resistance.

5. The displacement resistance varied from 0.85% equivalent grade, for a hard smooth asphalt or bituminous concrete to 1.6% for a soft tar-macadam road, and was practically constant, for all speeds considered, on any given road.

6. The impact resistance increases with the velocity, with the total weight of vehicle, and with increasing road-surface roughness. In these tests, the impact resistance of good asphalt or bitulithic or other smooth pavement, was practically negligible, and reached its highest values on granite-block roads with sand-filled joints, and on badly worn macadam pavements. The rate of increase of impact resistance with speed was most marked on the roughest roads.

7. At the vehicle speed of 20 km. (12.4 miles) per hour, the air resistance for the vehicle tested, assumed to be dependent only on the speed, was roughly 0.11% equivalent grade; that is, from 4% of the highest, to 12.5% of the lowest, total tractive resistance.

8. The following urban pavements are enumerated in the order of their desirability for vehicle operation from the point of view of tractive resistance at 20 km. (12.4 miles) per hour, as found in this investigation: asphalt, wood-block, hard smooth macadam, brick-block, granite-block with cement-filled joints, cinder, gravel, and granite-block with sand-filled joints.

9. The equivalent grade at 20 km. (12.4 miles) per hour of a badly worn macadam road, was found to be nearly three times as great as that of the best asphalt road tested. This means, at this speed, a consumption of energy at wheel treads, of nearly three times as much on level poor macadam roads as on level good asphalt roads.

10. Increasing the gross weight of the vehicle by 12%, through load, was found to have no effect on tractive resistance within the observed speed limits for smooth roads in good condition; but on rough roads, a distinct increase in tractive resistance with this extra weight was observed.

11. The presence of a layer of dust, say 1 cm. thick, on a fair macadam road, was found to increase the equivalent grade of tractive resistance, at all tested speeds, by about 0.15%.

12. A freshly tarred and therefore soft tar-macadam road was found to have an increased equivalent tractive resistance, at substantially all tested speeds, of about 0.5%. The tires in this case sank about 0.8 in. into the road-bed, the gross car-weight being 4710 pounds.

13. The total range of tractive resistance equivalent grade covered in the tests, was from 0.93% on the best asphalt road, at lowest speed, to 2.7% on the worst macadam road, at nearly the highest speed.

USE OF AMERICAN WATER PIPE IN EGYPT

An article in *The Ironmonger* of London, by Percy G. Donald describes the construction of a number of water lines in Egypt for the British War Office. Most of the lines were from 3 to 6 in. diam. Standard screw-pipe of British, Canadian, and American make, was used and the American was found to be by far the most satisfactory.

The principal defect in the British and Canadian pipe was the inferior methods used in protecting the threads. The regular practice on the British pipe was to wrap a few thicknesses of canvas around the threads. By paying an extra charge the pipe could be shipped with a protector that was so narrow that it frequently allowed the end of the thread to be burred over, making it difficult to remove the protector and increasing the danger of cross-threading. The threads on about 15% of the British pipe had to be re-cut in the field, which was particularly troublesome as all this work had to be done by hand.

Pieces of hoop-iron were used on the Canadian pipe. These frequently came off, but were about as valuable off the pipe as on it. Nevertheless on account of the pipe itself being heavier, the proportion of damaged threads was less than for the British pipe. On the other hand the protectors on the American pipe were so effective that there were no damaged threads at all.

The sockets of the British pipe have the thread carried to the edge, the thread is not tapered, and a burr is frequently left at the end of the thread. The result was many damaged threads and a great deal of cross-threading when the pipe was put together. The British standard for 2½ to 6-in. pipe is eleven threads to the inch, while the American is eight threads to the inch. That the British standard is too fine for such large pipe was shown by the great amount of trouble from cross-threading. The same-sized gang could lay twice as much American pipe as British pipe in a day. Leakage after the line was completed was almost unknown in the case of the American pipe, while a great deal of trouble was experienced from this cause with the British pipe.

The production of natural gas in the United States during 1915 was 628,578,842,000 cu. ft., valued at $101,312,381 or $0.1612 per 1000 cu. ft. This was an increase of 6% over the amount produced in 1914. Of the total production, 217,202,943,000 cu. ft., or 35%, was distributed to 2,195,081 domestic consumers at an average price of $0.2832 per 1000 cu. ft. The remainder was distributed to 18,358 industrial consumers at an average price of $0.097 per 1000 cu. ft. The total production in California was 21,891,035,000 cu. ft., valued at $4,069,004, or $0.1859 per 1000 cubic feet.

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CONCRETE CONSTRUCTION DURING COLD WEATHER

For satisfactory concrete work at low temperatures it is necessary to heat the sand, pebbles, or broken stone, and mixing water so that the mixture will have a certain minimum temperature, then to place the concrete quickly and maintain the heat until early hardening has been completed. This does not mean that there are no limitations to the practicability of concrete construction in cold weather, but that if a few simple precautions and protective measures are used, winter concrete work will be as successful as that done in warm weather. The principal thing to prevent is freezing of the concrete the first few days after placing.

The sand and pebbles or broken stone used must be free from frost or lumps of frozen material. As cement forms but a relatively small bulk of the materials in any batch of concrete, it need not be heated, but the mixing water should always be heated. Although adding common salt to mixing water will help to prevent freezing of concrete that has not hardened, there is a limit to the quantity of salt which may be added if the final strength of the concrete is not to be affected. Salt simply lowers the freezing-point of the mixing water; it does not supply what is most needed, heat. It delays, instead of hastens, the hardening of the concrete. Sand, pebbles, or broken stone, and mixing water must be heated so that the concrete when placed shall have a temperature of from 75 to 80°F. Some sands are injured by too much heat. This is also true of certain varieties of pebbles and broken stone. A temperature not greater than 150°F. will generally prove the most satisfactory. The concrete should be placed immediately after mixing so that the heat will not be lost before placing in the forms. Metal forms and reinforcing should be warmed with either hot water or a steam-jet before placing concrete. Ice, snow, and frozen concrete remaining on the forms from preceding work should be removed.

Even though the materials have been heated and the concrete placed immediately after mixing, it will lose much of its heat if not protected from low temperatures.

It should, therefore, be protected immediately after placing. Canvas covering, sheathing, housing-in the work, or hay and straw, will furnish the required protection for some work. In addition, small oil or coke-burning stoves or salamanders may be used in enclosed structures. Temperatures which may not be low enough to freeze concrete may, nevertheless, delay its hardening for a considerable time. Concrete placed when the temperature is low and remains low for some time afterward, is not safe for use as soon as though placed during warmer weather.

If the work is unavoidably delayed or interrupted, the concrete should be covered until construction is resumed. Parts of the work should be covered and protected as soon as completed. In severe cold weather, continue this protection for at least five days. During cold weather it is particularly important not to remove forms too early.

Frozen concrete sometimes closely resembles concrete that has thoroughly hardened. When it is struck with a hammer, it will often ring like properly hardened concrete. Before removing forms, examine the work carefully to see whether it has hardened or is simply frozen. To determine this, remove one board from some part of the forms, and pour hot water on the concrete or turn either the flame of a plumber's blow torch or a jet of steam under pressure against the concrete. If the concrete is frozen, the heat will soften it by thawing the contained water.

MANUFACTURE OF ELECTRO-CHEMICAL PRODUCTS

The chief products made by the aid of the electric current are aluminum, phosphorus, silicon, sodium, graphite, chlorine, oxygen, hydrogen; ferro-alloys, copper, titanium, vanadium, and other alloys; calcium carbide, carborundum, and other abrasives; caustic soda, caustic potash, sodium, peroxide, chloride of lime or bleaching powder, carbon bisulphide and muriatic acid. According to a report issued by the U. S. Bureau of Census, the value of electro-chemical products has increased from $18,450,000 in 1909 to $29,600,000 in 1914. This does not include iron and steel made in the electric furnace, which also falls under this class. The extent to which we are dependent on electro-chemical products is little realized. The manufacture of these products has been steadily increasing, but today the supply is far short of the demand, due, in many instances, to the inability to obtain permission from the Government to use more power at Niagara Falls, the great electro-chemical centre. Of 36 establishments reporting in 1914 manufacturing these products, 18 were in New York, 4 in Michigan, 3 in California, 2 each in Pennsylvania and West Virginia, and one each in several other States. Most of the plants in the State of New York are at or near Niagara. The 30th semi-annual convention of the American Electrochemical Society, whose membership includes the foremost electro-chemists of the World, was held at New York, September 27 to 30, at the time of the Exposition of Chemical Industries.

Sterilizing small amounts of water may be done in the following manner. Take a level teaspoonful of chloride of lime and rub it up in a teacup with a little water to a thin paste free from lumps. This should then be made up to a cupful and diluted with three more cupfuls of water and poured into a bottle tightly corked. This is a stock solution and will keep for a week if tightly corked. A teaspoonful of this stock solution should be added to each two-gallon pail of drinking water, thoroughly mixed, and allowed to stand for a few minutes. This will give about one-half part of free chlorine to a million parts of water, which will destroy all typhoid and dysentery-producing germs in 10 minutes.—*Engineering News.*

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The New Era of Higher Steam Pressures*

By ROBERT CRAMER†

During the past year much discussion has taken place concerning the advent of higher steam pressures. These expressions are often merely opinions, at times they are prophecies pronounced with more or less authority, but occasionally they are contained in news of an important action that has been taken. In the latter class belong the reports of several proposed installations of steam turbine units of considerable size, to operate under a steam pressure of 350 lb. per sq. in. As steam pressures of 200 lb. per sq. in. are standard in large power stations at the present time, and pressures over 225 are considered high, these few installations for 350 lb. must be regarded as innovations, although pressures decidedly higher have been used occasionally.

Theoretically, any increase of either the pressure of the steam or of its temperature by superheating it means an increase in the efficiency to which a prime mover using the steam may possibly attain under ideal conditions. During the last decade, the efforts of steam engineers have been for the most part in the field of superheat. The difficulties incident to high steam temperatures have been met gradually, until a temperature of about 600° F. corresponding to about 200° superheat, at a pressure of 200 lb. per sq. in. has been reached and is considered a practical standard. While this temperature is being handled successfully in both large and small plants, it is not thought safe to go much beyond it, because of troubles with constructional parts at higher temperatures, and with lubrication in the case of piston engines.

Further increase of steam pressure, keeping the temperature of the steam constant, means a reduction of superheat. As the temperature of saturation rises only slowly with the pressure, the latter would have to be raised to 1575 lb. per sq. in. before the superheat would completely disappear. At that pressure the temperature of saturated steam is 600° F. The theoretical gain in efficiency due to any pressure within this wide range from 200 lb. to 1575 lb. per sq. in. depends not only upon the pressure itself, but also upon other conditions of operation, and especially upon the exhaust pressure. The relative gain is much larger in case of non-condensing operation than it is in the case of exhaust into a vacuum.

The following table shows the theoretically possible gain in efficiency of steam prime-movers, due to increase of pressure without changing steam temperature of 600° F. Comparison is made with the efficiency at 200 lb. per sq. in. pressure.

*Paper prepared for annual convention of National Electric Light Association.

†Consulting engineer, Chicago, Illinois.

POSSIBLE GAIN AS AGAINST 200 LB. PER SQ. IN. PRESSURE.

Steam pressure lb. per sq. in.	With atmospheric exhaust %	With 29 in. vacuum %
300	14.8	4.9
400	23.5	9.7
500	27.5	11.5
600	32.0	13.4
1574	55.2	22.6

It is not claimed that these gains in efficiency can be obtained in practice, because the extent to which the theoretically possible efficiency can be realized may be different when the two cases are compared. A greater gain even is logically possible, but in general, any such departure as the radical increase in steam pressure introduces new sources of loss, and the practically obtainable gains may reasonably be expected to be less than those given in the table. The possible improvement in economy is so great, however, that a careful investigation of the practical possibilities is warranted.

The first important subject in the investigation of the practical possibilities is the recognition of those factors which tend to reduce the economy with advancing pressures. The tabulated figures are based upon a comparison of the degree of utilization of the heat contained in the boiler steam, but they leave out of consideration the boiler efficiency, that is, the degree to which the boiler utilizes the heat generated in the furnace. Higher steam pressures mean higher temperature of the water in the boiler, and consequently higher temperature of the gases of combustion as they leave the boiler heating surface. It can be shown that for 600-lb. pressure the corresponding loss is about 4% of the heat absorbed by the same boiler at 200-lb. pressure. This amount can easily be recovered by a suitable economizer or air pre-heater, which is neither expensive nor difficult to install or maintain.

After the steam leaves the boiler the losses in steam-turbines and steam-engines are of an entirely different character. In turbines the losses are chiefly because of friction and leakage. The proportion of these losses in present turbine types is considerably higher in the high-pressure stages than in the low-pressure end. It is to be expected that when steam pressures are greatly increased the losses at the high-pressure end will increase more rapidly than the theoretical gain, and a certain pressure will be reached beyond which further increase is useless. Just where this ultimate pressure lies can be definitely decided only by experiment on a large scale.

In piston-type steam-engines the losses have been chiefly because of the temperature differences incident to the expansion of the steam in the cylinder, although the full significance of this fact has not been recognized

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until recently. Higher steam-pressures mean larger temperature differences during expansion. The losses because of these temperature differences, in the common types of steam-engines, might easily nullify the gain which otherwise could be obtained by raising the pressure. Here, as in the case of the turbine, the skill of the designer has already pointed the way. The uniflow type of steam-engine instead of suffering a loss of efficiency from temperature changes takes advantage of them, and the careful investigator recognizes the significance of this advantage in the case of high steam pressures. The work of verifying this expectation in practical installations of considerable size is already under way.

The practical determination of the economic value of these proposals concerning high steam-pressures involves many questions of detail which are often puzzling but seldom insurmountable. As is often the case in creative engineering work, experience in other lines points the way, and frequently the obstacles are of a temporary commercial character. High-pressure apparatus which is quite suitable can often be obtained only at high cost, whereas the nature of its construction should make it as inexpensive as standard goods, once the demand is sufficient to warrant quantity production. One practical consideration lies in the province of the turbine designer, that of corrosion due to moisture entrained in the steam. The higher the initial steam pressure the larger the proportion of liquid contained in the steam at a given point in its path through the turbine. The presence of this moisture is the principal cause of blade corrosion but the problem is not peculiar to high pressures, as it is always present in steam-turbines. High steam pressures merely enhance its importance, but it can be met by the same means that are employed at present. It is interesting to note that in one way this increased proportion of moisture is an advantage. It reduces the required amount of condenser surface and the net amount thus saved in the cost of installation may easily offset the expenditure due to greater blade corrosion.

One problem peculiar to reciprocating engines is that of lubrication. Higher steam pressures necessitate larger surfaces or better lubrication on all parts that bear these pressures. In explosion engines, especially those of the diesel type, more difficult problems of the same character have been solved successfully. The experience thus collected can be used directly in the design of high-pressure steam-engines.

The same can be said of the problem of dealing with the reciprocating masses. For a given case these masses will be heavier than for lower pressures, because the parts must be stronger to withstand the larger forces. The pressure variations during each revolution are also more pronounced on account of the higher rate of expansion, which, in the uniflow type of engine, takes place in one cylinder. That these questions can be met adequately has been shown by the development of the diesel engine. The last mentioned question is, ultimately, one of strength of constructional parts and it therefore belongs in the large class of problems presented by the fact that higher steam-pressures demand stronger designs or better material, in order to be as safe as standard apparatus for lower pressures.

The most important problem of this class is that of the boiler. If standard boiler-designs are retained in type, but are strengthened so as to be adequate for higher pressures, the practical difficulties and the cost of construction soon increase so much that the ultimate economical result, in spite of a theoretical gain, would be a net loss. In modern boilers, the water-tubes have a large factor of safety, while that of the drum parts is low. The construction of a high-pressure boiler made entirely of tubes suggests itself, but this idea involves radical changes in boiler designs, because in present types, the drum (with its water level) is the stabilizing element, which regulates the all-important water circulation.

The development of the Winslow sectional boiler, a product created during the last few years, shows that large drums in water-tube boilers can be abandoned without sacrifices of water circulation or steady operation. The final development in this direction will be a boiler which is safe and reliable when used with high pressures, which is steady in operation, and the cost of which is not so high as to interfere with the realization of the economical advantages of high steam pressures.

Most boiler fittings, such as safety valves, blow-off valves, steam gauges, etc., of sufficient strength to be suitable for pressures up to 600 lb. per sq. in. are already available. The same may be said about valves, fittings, piping, and such auxiliaries as feed-pumps, which necessarily are subject to the boiler pressure. While the cost of most of these articles is still rather high, it should be noted that the sizes of pipes, valves, and fittings required, become considerably smaller as the pressure is increased, on account of the increased density of the steam and the reduced steam consumption for a given power.

A careful survey of the field seems to indicate that the movement toward higher steam-pressures in power-plant work has been well started and is steadily gaining force. Within a short time, higher pressures may be expected to become general in important plants. While it is hardly reasonable to expect the general introduction of pressures as high as 1500 lb. per sq. in. or, in other words, the use of saturated steam of 600° F. temperature, pressures of 400, 500, and even 600 lb. per sq. in. seem highly probable.

The oil and gas department of the California State Mining Bureau is preparing to construct a building at Taft for a field headquarters. The building will be of corrugated iron with a brick vault for the storage of copies of well logs and other data.

Artificial-ice making requires from 30 to 50 kilowatt-hours per ton of ice produced, according to statistics from several plants at Chicago during 1915. The average was 41.6 kilowatt-hours per ton.

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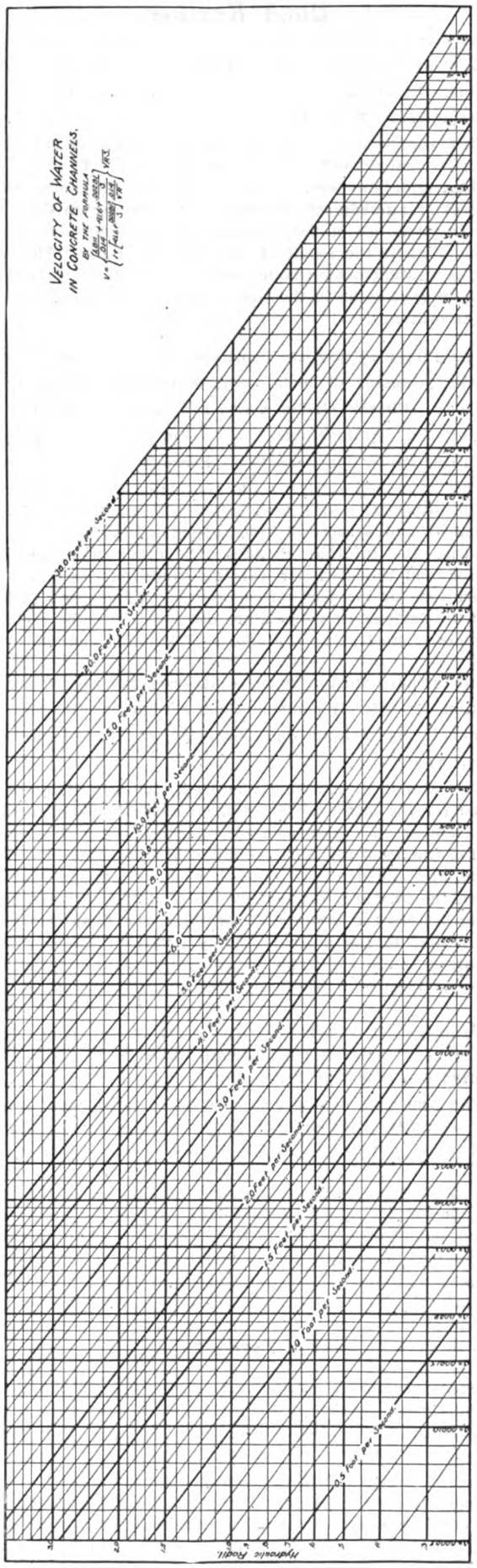
Engineers' Note Book

CHART FOR DETERMINING VELOCITY IN CONCRETE CANALS

By GEORGE HENRY ELLIS*

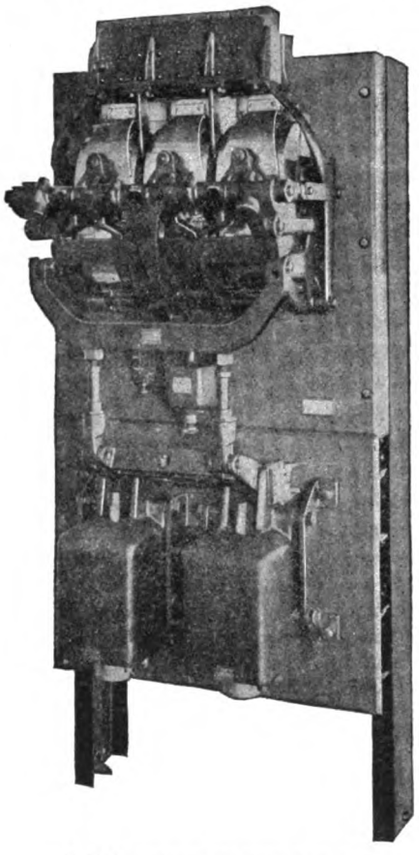
The accompanying chart may be used for computing the velocity in concrete-lined canals having hydraulic radii up to 3.5 and with slopes from 0.00005 or about 3 in. to the mile, up to 0.5. Thus for a hydraulic radius of 1 and a slope of 0.0002 or about 1 ft. to the mile, the velocity is not quite 1.5 ft. per second. The value of $n = 0.014$ in Kutter's formula is based on Bulletin No. 194 of the U. S. Department of Agriculture.



Industrial Progress

A 20,000-AMPERE DIRECT-CURRENT CIRCUIT-BREAKER

The 20,000-ampere direct-current circuit-breaker shown in the illustration is the most recent solenoid-operated type of circuit-breaker developed by the General Electric Co. for controlling direct-current circuits of unusually high capacity. The normal continuous rating is 20,000 amperes. This circuit-breaker is one of four of the same capacity built for the Aluminum Company of America for installation at Massena, New York. The closing and opening movements under normal conditions are controlled by a single-pole double-throw control-switch mounted at a distance from the breaker. On overload or short circuit the breaker opens automatically by means of a direct-acting trip. The breaker is mounted on a 2½-in. slate panel. The solenoid mechanism is supported by a steel base.



20,000-AMPERE CIRCUIT BREAKER.

*Fort Shaw, Montana.

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Book Reviews

How to Build-Up Furnace Efficiency. By Jos. W. Hays. P. 156. Ill., index. Jos. W. Hays, publisher, Rogers Park, Chicago, 1916. Price, $1.

This work is in its 10th edition, revised and enlarged, and is described as a hand-book of fuel efficiency. This is an important topic, frequently discussed in technical papers, and the subject of numbers of text-books. The author apologizes for the frequent use of the personal pronoun, but says that the whole book is the result of his own experience. The author speaks straight out on boiler firing, and engineers should find something of value in the book. Some of the sketches are out of the ordinary.

The Physico-Chemical Properties of Steel. By C. A. Edwards, professor of metallurgy, Manchester University. P. 226. Ill. Charles Griffin & Co., Ltd., London, and J. B. Lippincott Co., Philadelphia, 1916. For sale by *Mining and Scientific Press*, San Francisco. Price, $3.50.

This is a well-written book, thorough, and comprehensive. Much information has been sifted into readable form. The chemical and structural constitution of steels is described, likewise the internal changes that occur when steels are heated and cooled under varying conditions, and the transformations of the iron-carbon system. High-speed tool-steels and the various alloy steels are discussed, also the theories of hardening steels, and the effects of sulphur and phosphorus.

Molesworth Pocket Book of Engineering Formulae. 27th edition. P. 865. Ill., index. Spon & Chamberlain, New York. For sale by *Mining and Scientific Press*, San Francisco. Price, $1.50.

This standard English pocket-book has been thoroughly revised for the latest edition and an electrical supplement has been added. To those who are unacquainted with the source and character of the book, we might say that if we took Trautwine, and added a dash of both Kent and Foster and boiled down the mixture, eliminating much of the text and leaving little besides the tables and formulae, the final result would be similar to the present volume. Part of the contents is, naturally, more applicable to English than to American practice, but most of is is equally useful in both countries.

Tacheometer Surveying. By M. E. Yorke Eliot. P. 145. Ill., index. Spon & Chamberlain, New York. For sale by *Mining and Scientific Press*, San Francisco. Price, $2.

The American engineer is so used to considering a transit as incomplete without a vertical arc, level on the telescope, and stadia hairs, that it might be well to explain that a transit with these attachments is called a tacheometer in England. The book is devoted to a thorough explanation of the elementary principles of stadia surveying, which the author states is not sufficiently treated in the standard English treatises on surveying. However, the material contained in the present volume is similar to that contained in several American books. In fact, the book is of slight interest to American engineers except as indicating that English practice is far behind American in some branches of surveying.

Practical Safety Methods and Devices. Manufacturing and engineering. By George Alvin Cowee. P. 434. Ill., index. D. Van Nostrand Co., New York, 1916. For sale by *Mining and Scientific Press*, San Francisco. Price, $3.

If all the safety-first publications issued regularly by large corporations and the new books on the subject are studied by employees and the public, valuable results must follow. Statistics are proving this so, but more lessons are needed. In the preface the author states that industrial accidents in the United States cost 35,000 lives and $500,000,000 yearly. Also 350,000 injuries; while the minor accidents exceed 2,000,000. In the volume under review, accompanied by well-chosen pictures, the chapters deal with safety committees, buildings and fire, boilers, engines, elevators, electricity, shafting, belts and ropes, grinding tools, iron furnaces, handling materials, construction, railroads, mining, and explosives. Hand in hand with safety goes sanitation, welfare work, and first-aid, which are here well discussed. A useful book for mining and industrial companies' safety departments.

Examples in Alternating Currents. Vol. I. By F. E. Austin. Second Edition. P. 223. Ill., index. F. E. Austin, Hanover, N. H. For sale by *Mining and Scientific Press*, San Francisco. Price, $2.40.

This book is a reprint of the first edition, to which has been added considerable new material in the form of cuts and subject matter. The aim of the author has been to bring together the theory and practice in alternating currents by presenting problems and showing how they are solved by the application of mathematical formulae. The first 40 pages are devoted to definitions of fundamental units, signs employed in the formulae, trigonometrical functions, and calculus. Then follow the problems; the statement, the data, formulae which apply, and lastly the solution are presented in such a manner as to easily follow each step. The appendix contains a number of tables giving the values of variable quantities used in electrical engineering practice, so arranged as to include a wide range of values and to render evaluation convenient and rapid. To the student the book is valuable in that it trains and guides him in understanding the solution of electrical problems, while to the engineer its chief value is in the carefully tabulated arrangement of mathematical and electrical data.

Practical Hydraulics. By James Park. P. 284. Ill., charts, plans, index. Charles Griffin & Co., London, 1916; J. B. Lippincott Co., Philadelphia. For sale by *Mining and Scientific Press*, San Francisco. Price, $4.

The author of this work, who is professor in the University of Otago, at Dumedin, New Zealand, writes on many subjects, including assaying, cyaniding, surveying, and geology. In the South Island of New Zealand the author has many opportunities to study hydraulics, this being a region containing rivers, large ditches, hydraulicking, and dredging. The volume is termed a text-book for use in mining schools, technical colleges, and for hydraulic engineers. A good deal of the data has been drawn from American sources, and this, together with Australasian and foreign practice, makes a good mixture. Eight chapters cover principles, definition of terms, and the flow of water through orifices, open channels, over weirs, and in rivers; also friction in and discharge of pipes. Construction of dams, ditches, flumes, and pipes is of great importance, as these are subjected to varying pressures, sometimes suddenly abnormal, so examples of well-designed structures are described and shown by working plans. Costs are included. The last chapter covers the subject of water-power and water prime-movers. These include the latest type Pelton wheel and turbines. While American engineers are well versed in hydraulics, they should find something of value in this new book.

Centrifugal Pumps and Suction Dredgers. By E. W. Sargeant. P. 188. Ill., plans, index. Charles Griffin & Co., London, 1916; J. B. Lippincott Co., Philadelphia. For sale by *Mining and Scientific Press*, San Francisco. Price, $3.25.

Centrifugal pumps—belt, motor, oil-engine, or turbine driven—from 1 to 54-in. discharge, are now used in large numbers on dredges, for unwatering mines, elevating coarse and fine pulp

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in mills, fire purposes, sewage, and irrigation. Their popularity increases as they are better understood, and as improvements in efficiency are made. Although this book deals with English practice the information is useful to Americans, as the former have made good centrifugals for many years. In the United States the metallurgist and irrigation engineer have studied the centrifugal considerably, resulting in long-wearing liners and great capacity, respectively. For high lifts the multi-stage pump is a great success, the subject being covered in two chapters. Design of the pump-disc and casing are all-important, this being thoroughly discussed, including pattern making, molding, and machining. For priming a centrifugal several methods are given, also testing its capacity and efficiency. Pipe arrangements and valves are considered. As the rotary air-pump is closely related to the centrifugal it is briefly described. These are used at mines for various purposes. While the pump type of gold dredge is not worked much in America, it is a success in Australia, lifting large quantities of coarse gravel with ease up to 15-in. suction; but in harbors and rivers the suction dredge is operated everywhere, using centrifugal pumps. Here the engineer will find practical notes. Calculations and plans complete a work on an important machine.

HANDBOOK OF ROCK EXCAVATION METHODS AND COST. By Halbert P. Gillette. P. 825. Ill., index. Clark Book Co., Inc., New York, 1916. For sale by *Mining and Scientific Press*. Price, $5.

The author of this volume needs no introduction to the engineering profession, for his books on 'Cost Data' and 'Cost Keeping and Management Engineering' have long been standard works. This is the first of three books which are intended to cover the subjects of rock excavation, earth excavation, and tunnels and shafts. In the book under consideration there is much descriptive matter of the machines and devices employed, especially the different types of drills, steel, and bits. The subject has been divided under the general head of machinery, drilling operations, explosives, blasting methods, loading and transporting the broken rock. The application of methods and the cost are given with concrete examples of each type of work in mines, quarries, railroad cuts, canals, trenches, and sub-aqueous excavations. Considerable space has been given to the discussion of steam, compressed-air, and other power-plants, considering the cost of installation and relative efficiency of each type. There is described such a wide range of conditions of work that the engineer can scarcely fail to find in this book data on operations closely analogous to his own individual problem. The diversity of subjects treated makes it valuable to all branches of the engineering profession. The flexible leather binding and pocket size adds convenience to its usefulness.

THE CONSTRUCTION OF ROADS AND PAVEMENTS. By T. R. Agg. P. 414. Ill., index. McGraw-Hill Book Co., Inc., New York. For sale by *Mining and Scientific Press*, San Francisco. Price, $3.

The present importance of highway engineering is such a new development that the number of treatises on the subject is still comparatively small. The present volume is suitable both as a text-book for the student and a reference book for the practising engineer. The first chapter discusses the administrative control of highways. Surveys and the design of rural highways are then considered. The various types of roads and road-surfacing are then discussed in order, including earth, sand-clay, gravel, water-bound macadam, concrete, brick, wood-block, stone-block, penetration macadam, sheet asphalt, and asphaltic concrete. Testing of bituminous and non-bituminous materials is also discussed, and a chapter is devoted to dust-layers and bituminous carpets. Two particularly valuable chapters are devoted to selection of types of surface for highways and for city streets, in which the importance of the traffic census is shown. The book is well-illustrated, and a number of useful tables are included with the text.

New Publications

CONCRETING IN COLD WEATHER. The Portland Cement Association, 111 West Washington street, Chicago. P. 16. Ill. Contains a number of practical suggestions regarding methods of insuring good results under adverse weather conditions.

THE PRESERVATIVE TREATMENT OF FARM TIMBERS. Farmers' Bulletin No. 744, U. S. Department of Agriculture, Washington, D. C. P. 32. Ill. Discusses the decay of timber in farm structures and the methods for preservation.

BUILDING CODE SUGGESTIONS. Technical Letters No. 4 and 5, National Lumber Manufacturers Association, 925 Lumber Exchange, Chicago. These two 12-page pamphlets deal with the best methods of safeguarding frame buildings from fire. Letter No. 4 discusses fire stops, workmanship, and selection of materials, and Letter No. 5 is concerned with chimneys, flues, and fireplaces.

Civil Service Examinations

EXPERT ELECTRICAL AND MECHANICAL AID. Bureau of Yards and Docks, Navy Department. Salary $12.48 per diem. Duties cover the expert maintenance and supervision of the operation of navy-yard power-plants. Competitors will not be assembled for examination, but will be rated on technical education and experience and fitness. Graduation with a degree of mechanical or electric engineer and ten years' experience required. Age limit, under 55. Application form 1312.

Engineering Societies

IDAHO SOCIETY OF ENGINEERS. Ira F. Schaffner, secretary, Boise.

Los Angeles Section of AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Ford W. Harris, secretary, 1029 Higgins building.

Los Angeles Section of AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Edward Woodbury, secretary, 255 East 3rd street.

OREGON SOCIETY OF ENGINEERS. Orrin E. Stanley, secretary, room 409, City Hall, Portland.

Portland Section, AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Paul Lebenbaum, secretary, 45 Union Depot.

Portland Association of Members of AMERICAN SOCIETY OF CIVIL ENGINEERS. Charles McGonigle, president, care Western Sheet Metal Works.

San Francisco Association of Members of AMERICAN SOCIETY OF CIVIL ENGINEERS. E. T. Thurston, Jr., secretary, Mechanics Institute building.

San Francisco Section of AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Carl F. Braun, secretary, Hooker & Lent building.

San Francisco Section of AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. A. G. Jones, secretary, 811 Rialto building.

Southern California Association of Members of AMERICAN SOCIETY OF CIVIL ENGINEERS. W. K. Barnard, secretary, 701 Central building, Los Angeles.

UTAH SOCIETY OF ENGINEERS. Hugh C. Lewis, secretary, Capitol building, Salt Lake City, Utah.

The regular bi-monthly meeting of the San Francisco Association of Members of the AMERICAN SOCIETY OF CIVIL ENGINEERS was held October 17. J. D. Galloway, the association representative on the joint committee on preparedness gave an informal progress report, including a brief discussion of General Orders No. 32 of the War Department, relating to the Officer's Reserve Corps. The question of W. N. Frickstad's dismissal from the position of assistant city engineer of Oak-

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land was discussed and on motion of C. D. Marx, the chair was authorized to appoint a committee to give moral and financial support to the movement to test the legality of Mr. Frickstad's dismissal. The paper of the evening on 'The Calaveras Dam,' was presented by G. A. Elliott, chief engineer for the Spring Valley Water Co. On October 21, about 60 members of the Society were the guests of the Spring Valley Water Co. on a trip to the Calaveras dam, now somewhat more than half completed. The trip to Sunol was made by train, whence the members of the party were taken in automobiles to the dam-site. A side-trip to the company wells near Pleasanton and to the water temple at Sunol was also taken.

The annual meeting and election of officers of the ENGINEERS' CLUB of San Francisco was held on October 27. C. T. Hutchinson was elected president, W. H. Shockley and B. P. Legaré, vice-presidents, and C. E. Grunsky, Jr., treasurer for the coming year. The report of the retiring treasurer showed a net balance of about $1000 for the past year, after making the necessary deductions for a sinking fund to retire the club's notes given to raise money to furnish the permanent quarters. The report of the retiring president, E. B. Bumsted, showed that the club membership had increased from 294 to 445 during the past year.

Coming Conventions

AMERICAN MINING CONGRESS. Annual convention, Chicago, November 13-17. J. F. Callbreath, secretary, Munsey Bdg., Washington, D. C.

AMERICAN ROAD BUILDERS' ASSOCIATION. Annual convention, Boston, Mass., February 5-9, 1917. E. L. Powers, secretary, 150 Nassau street, New York. The National Good Roads Show of Materials and Machinery will be held in connection with this convention.

CITY MANAGERS' ASSOCIATION. Annual convention, Springfield, Mass., November 21-23. O. E. Carr, secretary, Niagara Falls, New York.

MID-WEST CEMENT USER'S ASSOCIATION. Annual convention. Omaha, Neb., March 6-10, 1917. Frank Whipperman, secretary, 28th avenue and Sahler street, Omaha.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS. Annual meeting, New York, November 16-17. D. H. Cox, secretary, 29 West 39th street, New York.

TENTH ANNUAL CEMENT SHOW, Chicago, February 7-15, 1917.

Personal

F. A. NIKIRK has been appointed assistant city engineer of San Jose, California.

I. E. HOWE, of the Engineer Corps of the U. S. Army, is making a survey of the harbor at Santa Cruz, California.

FORD W. HARRIS, secretary of the Los Angeles Section of the American Society of Mechanical Engineers, has been admitted to the bar.

A. A. ACHER, of the Engineer Corps of the U. S. Army, is in charge of construction of fortifications at Fort MacArthur, San Pedro, California.

CARL J. RHODIN, formerly engineer for the J. G. White Engineering Corporation, has opened offices in the Alaska Commercial Bdg., San Francisco.

W. W. WEIR, drainage engineer for the U. S. Department of Agriculture is investigating proposed methods for draining the Truckee meadows near Reno, Nevada.

A. E. LODER, formerly division engineer for the California State Highway Commission, has resigned to become assistant chief engineer of the United States Office of Public Roads.

H. F. JACKSON has been elected president, J. K. MOFFITT and P. M. HOSKINS, vice-presidents, and F. J. BLANCHARD, secretary of the Sierra & San Francisco Power Company.

SAMUEL W. REYNOLDS has been elected captain and L. B. GROSS, HERBERT WOLF, R. H. NEDDERMAN, and BYRON PAUL, lieutenants of the aviation company of the National Guard of California, now being organized at Oakland.

DANIEL WILLARD, SAMUEL GOMPERS, FRANKLIN H. MARTIN, HOWARD E. COFFIN, BERNARD BARUCH, HOLLIS GODFREY, and JULIUS ROSENWALD have been appointed members of an advisory commission to be associated with the Council of National Defense.

W. J. DAVIS, JR., addressed a joint meeting of the San Francisco Sections of the American Society of Mechanical Engineers and American Institute of Electrical Engineers on October 27 on 'The Operation of Curtis Turbines and Reduction Gears for Ship Propulsion.'

CHESTER NARAMORE, formerly deputy State oil and gas supervisor, with headquarters at Taft, Cal., has resigned to become assistant petroleum engineer, for the U. S. Bureau of Mines, with headquarters at Washington, D. C. He will be succeeded by R. N. FERGUSON, who will have as his assistants, R. D. BUSH, J. H. DOUGHERTY, and G. MCGREGOR.

The following officers were elected for the coming year at the annual meeting of the International Irrigation Congress, held recently at El Paso, Texas. GEORGE ALBERT SMITH, Salt Lake City, president; J. S. DENNIS, Calgary, L. A. NARES, Fresno, KURT GRUNWALD, Denver, LAFAYETTE CLAP, Hatch, New Mexico, and J. B. MCNARY, El Paso, vice-presidents; ARTHUR HOOKER, Spokane, secretary.

Among the city engineers and assistant city engineers who attended the recent convention of the League of California Municipalities at Visalia were L. F. BARZELOTTI, Lodi; GEORGE S. HINCKLEY, Redlands; J. C. GARDNER, Napa; J. F. BYXBEE, Palo Alto; M. C. POLK, Chico; R. S. HAWLEY, Emeryville; W. T. KNOWLTON, Los Angeles; PERRY F. BROWN, WALTER N. FRICKSTAD, Oakland; JOHN A. MORTON, Santa Monica; EDWARD M. LYNCH, Glendale; ROBERT B. RAY, Bakersfield; H. D. CHAPMAN, F. J. CALKINS, Richmond; MILTON MAGGINI, San Jose; ERIC WOLD, Burlingame; LAWRENCE MAYE, Visalia; G. H. FREITAS, Modesto; B. E. CRONKHITE, Fresno; H. E. C. FEUSIER, San Anselmo; S. G. CHAMBERLAIN, San Fernando; A. B. COOK, Santa Barbara; F. P. MCCRAY, Sunnyvale; F. W. PEASE, Porterville; A. E. COWELL, Los Banos; R. V. ORBISON, Pasadena; E. P. JONES, San Francisco; and W. H. SHAFER, Selma.

Obituary

W. N. FORKER, a pioneer oil operator and for several years water-infiltration commissioner for Kern county, California, died October 2 at his home in Bakersfield.

VIRGIL G. BOGUE, one of the most prominent railroad engineers of the country, died October 15 on board a steamer on the way from Mexico to New York. He was chief engineer for the Union Pacific Railroad for several years and also chief engineer for the Western Pacific Railroad during its construction.

Commercial Paragraphs

The MOORE & WHITE CO. of Philadelphia, has issued a 40-page bulletin on 'Friction Clutches.'

The GENERAL ELECTRIC CO. has issued bulletin No. 44,419, a 24-page pamphlet on 'Railway Motor-Gears and Pinions.'

The PORTLAND CEMENT ASSOCIATION, 111 West Washington street, Chicago, has offered prizes for photographs showing uses of concrete in building construction. There will be a first prize of $25, a second prize of $10 and three other prizes of $5 each. The contest closes December 31.

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Western Engineering

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SAN FRANCISCO, NOVEMBER 6, 1916

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Contracts Pending

Bids will be Received		See Issue of News Bulletin
Nov. 6.	Blaine, Wash., Street Work	Nov. 6
Nov. 6.	Delano, Cal., Street Work	Oct. 30
Nov. 6.	Eureka, Cal., Street Work	Oct. 30
Nov. 6.	Fresno, Cal., Light	Oct. 30
Nov. 6.	Fresno, Cal., Street Work	Oct. 30
Nov. 6.	Fresno, Cal., Supplies	Oct. 23
Nov. 6.	Los Angeles, Cal., Sewers	Nov. 6
Nov. 6.	Los Angeles, Cal., Street Work	Nov. 6
Nov. 6.	Martinez, Cal., Street Work	Nov. 6
Nov. 6.	Salinas, Cal., Road Work	Oct. 9
Nov. 6.	Salinas, Cal., Road Work	Oct. 16
Nov. 6.	San Andreas, Cal., Bridge	Oct. 30
Nov. 6.	San Diego, Cal., Street Work	Nov. 6
Nov. 6.	San Francisco, Cal., Street Work	Nov. 6
Nov. 6.	San Jose, Cal., Bridge	Oct. 16
Nov. 6.	San Jose, Cal., Drainage	Oct. 23
Nov. 6.	San Rafael, Cal., Heat	Oct. 23
Nov. 6.	Santa Barbara, Cal., Bridge	Oct. 30
Nov. 6.	Santa Paula, Cal., Culverts	Oct. 30
Nov. 6.	Tulare, Cal., Light	Oct. 30
Nov. 6.	Whittier, Cal., Street Work	Nov. 6
Nov. 6.	Yreka, Cal., Bridge	Oct. 23
Nov. 6.	Yreka, Cal., Bridge	Oct. 30
Nov. 7.	Washington, D. C., Machinery	Oct. 30
Nov. 8.	Bakersfield, Cal., Machinery	Oct. 23
Nov. 8.	Corona, Cal., Street Work	Nov. 6
Nov. 8.	Fresno, Cal., Building	Oct. 16
Nov. 8.	Hillsborough, Cal., Sewer	Oct. 30
Nov. 8.	Monterey, Cal., Supplies	Oct. 16
Nov. 8.	Pasadena, Cal., Machinery	Nov. 6
Nov. 8.	Red Bluff, Cal., Bridge	Oct. 16
Nov. 8.	Salt Lake City, Utah, Miscellaneous	Nov. 6
Nov. 8.	San Diego, Cal., Bridge	Oct. 23
Nov. 8.	San Diego, Cal., Bridge	Oct. 30
Nov. 8.	San Francisco, Cal., Street Work	Nov. 6
Nov. 8.	San Francisco, Cal., Water Supply	Nov. 6
Nov. 8.	Stockton, Cal., Building	Oct. 30
Nov. 8.	Stockton, Cal., Road Work	Oct. 30
Nov. 9.	Bakersfield, Cal., Road Work	Oct. 23
Nov. 9.	Oakland, Cal., Sewer	Nov. 6
Nov. 9.	Sacramento, Cal., Street Work	Nov. 6
Nov. 9.	San Luis Obispo, Cal., Bridge	Oct. 16
Nov. 9.	Santa Ana, Cal., Culvert	Oct. 23
Nov. 9.	Santa Ana, Cal., Street Work	Oct. 23
Nov. 9.	Spokane, Wash., Street Work	Nov. 6
Nov. 9.	Ventura, Cal., Bridge	Oct. 23
Nov. 10.	Berkeley, Cal., Sewer	Nov. 6
Nov. 10.	Fresno, Cal., Building	Oct. 30
Nov. 10.	Richvale, Cal., Drainage	Oct. 30
Nov. 10.	Seattle, Wash., Street Work	Nov. 6
Nov. 10.	Seattle, Wash., Water Supply	Nov. 6
Nov. 10.	Washington, D. C., Building	Oct. 16
Nov. 11.	Washington, D. C., Machinery	Oct. 2
Nov. 13.	Everett, Wash., Road Work	Oct. 30
Nov. 13.	Marysville, Cal., Building	Nov. 6
Nov. 13.	Riverside, Cal., Building	Nov. 6
Nov. 13.	Sacramento, Cal., Building	Oct. 30
Nov. 13.	San Jose, Cal., Miscellaneous	Oct. 23
Nov. 13.	South Pasadena, Cal., Light	Oct. 30
Nov. 13.	Terra Bella, Cal., Irrigation	Oct. 16
Nov. 13.	Washington, D. C., Harbor Work	Oct. 30
Nov. 14.	Eureka, Cal., Bridges	Oct. 30
Nov. 14.	Hanford, Cal., Building	Nov. 6
Nov. 14.	Merced, Cal., Bridges	Oct. 30
Nov. 14.	Napa, Cal., Supplies	Oct. 30
Nov. 14.	Salt Lake City, Utah, Building	Nov. 6
Nov. 14.	Salt Lake City, Utah, Sewer	Oct. 30
Nov. 14.	Washington, D. C., Machinery and Supplies	Oct. 30
Nov. 14.	Waterford, Cal., Irrigation	Oct. 30
Nov. 14.	Watts, Cal., Street Work	Oct. 30
Nov. 14.	Willows, Cal., Bridges	Oct. 30
Nov. 15.	Coquille, Ore., Bridge	Nov. 6
Nov. 15.	Red Bluff, Cal., Bridges	Nov. 6
Nov. 16.	Richfield, Utah, Drainage	Oct. 30
Nov. 17.	Colusa, Cal., Building	Nov. 6
Nov. 17.	Fort Worden, Wash., Sewer	Oct. 23
Nov. 17.	Santa Paula, Cal., Street Work	Oct. 30
Nov. 17.	Walla Walla, Wash., Road Work	Nov. 6
Nov. 18.	Twin Falls, Ida., Building	Nov. 6
Nov. 20.	Colfax, Wash., Road Work	Nov. 6
Nov. 20.	Fresno, Cal., Machinery	Oct. 30
Nov. 20.	San Diego, Cal., Sewer	Nov. 6
Nov. 20.	Washington, D. C., Machinery	Oct. 30
Nov. 21.	San Francisco, Cal., Supplies	Oct. 30
Nov. 21.	San Rafael, Cal., Water Supply	Nov. 6
Nov. 21.	Washington, D. C., Machinery and Supplies	Nov. 6
Nov. 22.	Los Angeles, Cal., Supplies	Nov. 6
Nov. 24.	El Paso, Texas, Irrigation	Nov. 6
Nov. 28.	St. Ignatius, Mont., Irrigation	Nov. 6
Dec. 4.	Washington, D. C., Building	Oct. 30
Dec. 6.	Portland, Ore., Bridge	Sept. 25
Dec. 6.	Washington, D. C., Building	Oct. 23
Dec. 6.	Washington, D. C., Miscellaneous	Oct. 16

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Construction News

STREET AND ROAD WORK

Avon, Cal.—Contract for construction of highways in the vicinity of Associated Oil Co. plant has been awarded to Chadwick & Sykes, Crocker Bdg., San Francisco, for about $17,000.

Blaine, Wash.—Bids will be received until November 6 by E. E. Pruner, county clerk, for improvement of D street.

Colfax, Wash.—Bids will be received until November 20 by A. R. Metz, county auditor, for graveling 3¼ miles of permanent highway No. 13.

Corona, Cal.—Bids will be received until November 8 by M. Terpenning, city clerk, for grading and construction of 82,000 sq. ft. of concrete pavement with oil and screening surface.

Daly City, Cal.—Contract for street improvements in West End Homestead district has been awarded to Federal Construction Co., Sharon Bdg., San Francisco, for $135,858.50. Tibbits-Pacific Co. bid $144,832.17, and Peterson & Grier $147,122.30.

Following bids were received for construction of improvements in Vista Grande district No. 2: Tibbits-Pacific Co., $15,533.64; Peterson & Grier, $15,685.05; Ransome-Crummey Co., $17,013.02. All bids were rejected and work will be readvertised.

Los Angeles, Cal.—Board of Public Works will receive bids until November 6 for the following street work: warrenite pavement, concrete sidewalks and curbs, and granite-block and brick-block gutters on Maple avenue and adjacent streets; grading, oiling, and construction of concrete pavement, curbs, sidewalks, and gutters on Avenue 49; grading, oiling, and construction of concrete curbs, gutters, and sidewalks on Lincoln avenue; warrenite pavement, concrete curbs and sidewalks, granite-block gutters, and vitrified pipe storm-drains on 12th street and adjacent streets; warrenite pavement, concrete curbs, and granite-block gutters on 14th street; asphalt pavement and concrete gutters on St. Joseph's place.

Contract for improvement of Mission road has been awarded to George H. Oswald for $25,240.49.

Martinez, Cal.—Bids will be received until November 6 by C. E. Daly, town clerk, for grading Berrellesa street.

Bids will also be received until the same time for construction of sidewalks on Escobar street.

Napa, Cal.—Contract for grading and construction of concrete curbs and macadam pavement on Linn street has been awarded to George E. Errington, the only bidder, for $806.26.

Pocatello, Ida.—Contracts for grading, graveling, and curbing in districts No. 14 and 17 have been awarded to Francis McNally for $34,931.40 and $20,257.16, respectively.

Contract for street improvements in district No. 18 has been awarded to J. J. Carroll, Boise, for $29,578.62.

Contract for grading and graveling in district No. 19 has been awarded to Co-Operative Construction Co. for $2160.03.

Contract for construction of gravel bitulithic pavement in district No. 20 has been awarded to R. M. Barsden Co. for $41,601.79.

Sacramento, Cal.—Bids will be received until November 9 by M. J. Desmond, city clerk, for grading and construction of concrete curbs and gutters and asphaltic concrete pavement on concrete base on J street.

Contract for improvement of 31st street has been awarded to A. Teichert & Son.

Contract for improvement of Carnell avenue has been awarded to Clark & Henery Construction Company.

County highway engineer R. M. Morton commenced surveys for county highway system on November 1. A bond issue of $1,750,000 was voted recently for this system, which will consist of 125 miles of concrete-paved highways.

San Bernardino, Cal.—Board of Supervisors has decided to construct Lytle Creek highway. Estimated cost is $42,000 for the road itself and $14,000 for a bridge. The latter may not be built at present.

San Diego, Cal.—Bids will be received until November 6 by A. H. Wright, city clerk, for improving two blocks on 8th street.

San Francisco, Cal.—Board of Public Works will receive bids until November 6 for construction of concrete sidewalks for one block on Clement street.

Bids will be received until November 8 by Board of Public Works for the following street work: concrete sidewalks, granite curbs, and brick pavement for one block on Church street; concrete curbs and sidewalks and brick and asphalt pavement on 34th avenue.

San Rafael, Cal.—Directors of Marin Municipal water district have awarded contract for construction of road to mouth of Pine Mountain tunnel to Markle & Murphy for $7000.

Seattle, Wash.—Contract for construction of concrete sidewalks on Pine street has been awarded to Coluccio & Nibblett, 1642 Lane street, for $1641.

Contract for resurfacing Lake Washington boulevard has been awarded to R. G. Stevenson for $0.80 per sq. yd. or $5600.

Board of Public Works will receive bids until November 10 for construction of brick pavement on Rainier avenue.

Bids will also be received until the same time for construction of asphalt pavement, brick gutters, concrete curbs and sidewalks, and sewers and water-mains on 11th avenue Northeast and other streets.

Spokane, Wash.—Bids will be received until November 9 by Leonard Funk, commissioner of public works, for improvement of Nevada street.

Tacoma, Wash.—Contract for construction of Chambers Creek highway has been awarded to Olaf Swanson for $1784.

Tucson, Ariz.—Contract for grading several streets has been awarded to J. M. Pacheco & Co. for $5804.42.

Contract for construction of pavement, curbs, and sidewalks on several streets has been awarded to Warren Bros. Co. for about $50,000.

Walla Walla, Wash.—Bids will be received until November 17 by C. F. Dement, county clerk, for construction of permanent highway No. 13.

Whittier, Cal.—Bids will be received until November 6 by C. O. Trueblood, city clerk, for grading and construction of macadam pavement and concrete curbs, gutters, and sidewalks on Bright avenue.

SEWERS AND DRAINAGE

Berkeley, Cal.—Bids will be received until November 10 by A. G. Briggs, city clerk, for construction of 620 ft. of 6-in. sewer on Sacramento street.

Big Sandy, Mont.—Election has been called for January 8 to vote on bond issue of $29,300 for construction of sewer and water system.

Logan, Utah.—Contract for construction of sewer extension on Second North street has been awarded to William Evans for $8589.

Los Angeles, Cal.—Board of Public Works will receive bids until November 6 for construction of sewers on Echo Park avenue and Bellevue avenue.

Contract for construction of concrete storm-drain for Signal Hill drainage district has been awarded to James Kennedy, Washington Bdg., for $84,936.

Contract for construction of sewer in Florence Avenue district has been awarded to John Radich, the lowest of five bidders, for $112,306.87. Engineer's estimate was $134,779.56.

Oakland, Cal.—Bids will be received until November 9 by L. W. Cummings, city clerk, for construction of sewer on Maybelle avenue.

Redwood City, Cal.—Following bids were received for construction of storm-water drainage system for the Wellesley Park and Redwood Highlands districts: Dreyfus Bros., $9939.20; Eaton & Smith, $12,222.21; Tieslau Bros., $12,504.74. All bids were considerably higher than the engineer's estimate and were taken under advisement.

Reno, Nev.—Maurice Hayes, assistant state engineer, is making plans for draining about 10,000 acres of land in Truckee meadows.

San Diego, Cal.—Bids will be received until November 20 by A. H. Wright, city clerk, for construction of sewer system for University Heights district. Work includes about 29,000 ft. of 6 to 10-in. cement pipe. Estimated cost is $31,200.

San Francisco, Cal.—Following bids have been received for construction of sewers on Somerset street: Tibbitts-Pacific Co., $17,841.90; Grace & Bernieri, $20,222.60; Karl Ehrhart, $20,471.50.

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BRIDGES AND CULVERTS

Coquille, Ore.—Bids will be received until November 15 by R. R. Watson, county clerk, for construction of 180-ft. bridge over south fork of Coquille river. Alternate bids will be received for timber and steel structure. Plans from county clerk upon deposit of $5.

Hanford, Cal.—Contract for construction of Alcorn bridge over Kings river has been awarded to Grover U. Cole for $3117.30. H. E. Walker bid $3894.76, and W. A. Kettlewell & Sons $4895.

Red Bluff, Cal.—Bids will be received until November 15 by H. G. Kuhn, county clerk, for construction of four wooden bridges on Lassen highway.

San Anselmo, Cal.—Following bids were received for construction of Lansdale bridge: C. B. Cowden, $13,470 and $8 per cu. yd. for extra excavation; Macrae & Layaz, $13,225 and $5 for excavation; J. D. Hannah, $14,495 complete; W. C. Duncan & Co., $14,563 and $3 for excavation; L. A. Hinson, $12,973 and $3.50 for excavation. All bids were rejected because too high.

IRRIGATION AND WATER SUPPLY

El Paso, Texas.—Bids will be received until November 24 at office of U. S. Reclamation Service, Mills Bdg., for canal excavation involving 185,000 cu. yd. and levee construction involving 29,000 cu. yd. Particulars from U. S. Reclamation Service, Washington, D. C., Denver, or El Paso.

Medford, Cal.—Election has been called for November 27 for formation of irrigation district containing 1200 acres in vicinity of Gold Hill.

Oakland, Cal.—Foreclosure sale of property of Peoples Water Co. has been set for November 29. This sale is preliminary to the formation of the East Bay Water Co. under plans approved by the State Railroad Commission for reorganization.

St. Ignatius, Mont.—Bids will be received until November 28 at office of U. S. Reclamation Service, for construction of canal on Flathead project, involving 195,000 cu. yd. excavation. Work is from 8 to 15 miles north of Camas. Particulars from U. S. Reclamation Service, Washington, D. C., Denver, or St. Ignatius.

San Francisco, Cal.—Bids will be received until November 8 by Board of Public Works for extension of municipal waterworks.

State Water Commission has received the following applications to divert water:

E. W. Pereira, Fort Jones, 125 second-feet from Scott river for irrigation. Plans include concrete dam 8 ft. high and 60 ft. long, and a canal 7 miles long. Estimated cost is $48,500.

A. L. Richardson, Placerville, 1½ second-feet from creek flowing into Lake Tahoe for domestic use and for operation of small electric plant. Estimated cost is $1200.

H. O. Kohler and A. Schwartz, Washington, Nevada county, water from Scotchman's creek. Plans include dam 35 ft. long and 10 ft. high and a ditch 2 miles long. Estimated cost is $4725.

Farm Land & Investment Co., San Francisco, 200 second-feet from Feather and Yuba rivers for irrigation. Plans include several large electrically driven centrifugal pumps. Estimated cost of entire work is $62,000.

Twenty-One Mining Co., Phoenix, Ariz., 1½ second-feet from Kanaka creek for mining and milling. Plans include pipe-line 2100 ft. long.

San Rafael, Cal.—Bids will be received until November 21 by Marin Municipal water district for construction of Pine Mountain tunnel. Estimated cost is $500,000.

The directors of the district have authorized A. R. Baker, engineer for the district, to enlarge the spillways on the two dams formerly owned by the Marin Water & Power Company.

Seattle, Wash.—Contract for construction of water-mains on Rainier avenue has been awarded to G. Argentieri & Co., 989 Rainier avenue, for $7742.

Bids will be received until November 10 by the Board of Public Works for construction of water-mains on Rainier avenue.

Susanville, Cal.—Honey Lake Valley Mutual Water Users Association has been incorporated to develop water for irrigation. The directors are C. W. Hallowell, W. D. Minckler, W. D. Minckler, Jr., Susanville, and F. W. Collins and Carl J. Young, Reno.

Twin Falls, Ida.—L. C. Kelsey, Selling Bdg., Portland, Ore., is preparing plans for water system. Estimated cost is $300,000.

Waterford, Cal.—Complete plans and specifications for construction of part of system for Waterford irrigation district are on file at office of Western Engineering. This work includes 209,800 cu. yd. of excavation and the construction of 2200 lin. ft. of tunnel 8 ft. in diameter.

Willows, Cal.—Board of Supervisors has granted petitions for organization of Jacinto and Princton-Codora-Glenn irrigation districts and has called election in each district for December 9. The Jacinto district will contain 19,000 acres and the estimated cost of the work is $190,000. The Princton-Codora-Glenn district will contain 17,000 acres and the estimated cost of the work is $136,000.

LIGHT, HEAT, AND POWER

Pocatello, Ida.—Contract for construction of lighting system in district No. 20 has been awarded to Pocatello Electric Co. for $51,513.73, using pressed steel posts.

RIVER AND HARBOR WORK

Artesia, Cal.—Bids are being received by Levi Carse, president New San Gabriel levee-protection district, for removing 50,000 cu. yd. of sand from dry bed of San Gabriel river and depositing material in levees about 4½ ft. high on either side of river.

Healdsburg, Cal.—Contract for construction of levee along Dry creek has been awarded to W. L. Proctor for $850.

Newport Beach, Cal.—Charles T. Leeds, Central Bdg., Los Angeles, is preparing plans for jetty construction under the $125,000 bond issue recently voted for this work.

San Rafael, Cal.—Bond issue of $50,000 for improvement of channel failed to receive the necessary two-thirds majority.

RAILROAD WORK

Portland, Ore.—Preliminary surveys for Oregon, California & Eastern Railroad have been completed. Plans include line from Bend to Crane Creek Junction with branches to Burns and Narrows. A line will also be built from point near Burns to Silver Lake with branches to Klamath Falls and Lakeview. The total length of line is 425 miles and the estimated cost is $6,000,000. Plans for financing the construction of the road are now under way.

San Diego, Cal.—State Supreme Court has rendered decision annulling order of State Railroad Commission to Santa Fe Railroad to reconstruct abandoned railroad from Temecula to Fallbrook, about 12 miles.

Santa, Ida.—Santa & Western Railroad has been incorporated to construct 15-mile railroad from Marsh to Santa. F. A. Blackwell, Coeur d'Alene, is interested.

Wendover, Utah.—Contract for construction of railroad from Wendover to Gold Hill, 43 miles, has been awarded to Utah Construction Co., Ogden and San Francisco.

BUILDING CONSTRUCTION

Colusa, Cal.—Election has been called for November 17 to vote on bond issue of $20,000 for construction of school building. An issue of $65,000 has already been voted.

Dunsmuir, Cal.—Bond issue of $30,000 for construction of school building failed to receive the necessary two-thirds majority.

Hanford, Cal.—Bids will be received until November 14 by G. H. Rogers, secretary board of trustees, for construction of gymnasium-building for high school.

Martinez, Cal.—Contract for construction of school building has been awarded to Philbrick & Colvin, Lodi, for $38,625.

Marysville, Cal.—Board of education will receive bids until November 13 for construction of building for grammar school. Estimated cost is $18,000.

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Oakland, Cal.—Monson Bros., 1907 Bryant street, San Francisco, were low bidders at $103,729 for construction of tuberculosis hospital at Livermore.

F. T. Kennedy, 954 Rose avenue, was low bidder at $20,532 for construction of isolation ward at county hospital.

Riverside, Cal.—Bids will be received until November 13 by A. N. Wheelock, clerk of board of education, for construction of two school-buildings. Separate bids will be received on each building for the general contract, plumbing and galvanized iron, blackboards, electric wiring and fixtures, and heating and ventilating plant. Plans from G. Stanley Wilson, Virginia Block, upon deposit of $15 for each set.

Salt Lake City, Utah.—Bids will be received until November 14 by Gordon Snow, city recorder, for construction of pumphouse for main trunk-sewer. Plans from S. Q. Cannon, city engineer, upon deposit of $5.

San Francisco, Cal.—M. C. Couchot, 110 Sutter street, is receiving bids for excavating and timber piling for five-story reinforced concrete factory-building to be erected at 8th and Brannan streets.

Twin Falls, Ida.—Bids will be received until November 18 by county commissioners for construction of county hospital. Separate bids will be received on the general contract, plumbing, and heating.

Vallejo, Cal.—Sperry Flour Co. will construct reinforced concrete warehouse costing $500,000 in place of building recently burned.

Washington, D. C.—Welch Bros. & Hannaman, Kalispell, Montana, were low bidders at $32,874 for construction of extension to post-office at Boise, Idaho.

Willows, Cal.—New plans will be prepared and a new call for bids issued for construction of post-office. Bids received recently were considerably more than the $75,000 available for the work.

MACHINERY AND SUPPLIES

Bakersfield, Cal.—City manager Wallace M. Morgan has been authorized to spend $600 for additional fire-hydrants.

Bogota, Colombia.—City has appropriated $2500 for purchase of garbage-carts and a small asphalt-plant. Information regarding the carts from the Administrador de Aseo Publico, and regarding the asphalt-plant from the Ingeniero Municipal. Both officials should be addressed in Spanish.

Los Angeles, Cal.—Bids will be received until November 22 by city purchasing agent for furnishing cotton rubber-lined fire-hose.

Pasadena, Cal.—Bids will be received until November 8 by H. Dyer, city clerk, for furnishing a 2-ton motor truck.

San Francisco, Cal.—Contracts for furnishing 60 tons of Wellington coal for light-vessel No. 70 and 119 tons for vessel No. 76 have been awarded to Western Fuel Co. for $504 and $936.75, respectively.

Washington, D. C.—Bids will be received until November 21 by Bureau of Supplies and Accounts, Navy Department, for the following: for delivery at Mare Island, Cal.: 1 automobile ambulance, schedule 293; 200 gross hand-frame hacksaw-blades, 684 carpenter's hammers, 13,550 lb. sheet lead, schedule 296; 1000 five-candle power instrument-lamp sockets, 200 lb. copper pipe, schedule 297; for delivery at Puget Sound, Wash.: six alternating-current 220-volt motors, schedule 294; 150 brass-base safety-treads, schedule 296; 285 lb. hard sheet-rubber, schedule 297; for delivery at San Diego, Cal.: 3 special tee railroad-crossings, 2 frogs and switches, 60,000 lb. rails, 1400 lb. railroad spikes, schedule 292.

MISCELLANEOUS

Salt Lake City, Utah.—Bids will be received until November 8 by W. J. Lynch, secretary State Board of Land Commissioners, for drilling a well to a depth of 600 ft. at a point near Yale siding on Salt Lake Route. Well is to be started with 12-in. casing.

Seattle, Wash.—Contract for construction of first four sections of floating wooden dry-dock for Seattle Construction & Dry Dock Co. has been awarded to John McAteer for $225,000.

Building Permits

In SAN FRANCISCO; $2500 and over in valuation.

OCTOBER 26

Dwelling Raising and Alterations—Cost $2800. M. F. Welch, owner. W 11th Ave 125 S Cabrillo.

Two Story Frame Flats—Cost $15,000. Nathan Delbanco, owner. E 5th Ave 453 N Lake.

Three Story Frame Tenements—Cost $10,000. John J. Binet, owner. W Ramona 150 S 14th.

OCTOBER 27

Four Story Brick Tenements—Cost $35,000. L. D. Stoff, owner. N Bush 45 E Taylor.

Dwelling Alteration—Cost $3500. G. S. Trowbridge, owner. 125 Commonwealth Ave.

Two Story Frame Dwelling—Cost $2800. Jos. O. Dillingham, owner. W 21st Ave 200 N Ulloa.

Four Story Concrete Tenements—Cost $35,000. J. G. Kincannon, owner. N Post 163 E Leavenworth.

Two Story Frame Dwelling—Cost $2600. A. R. Duffee, owner. N Kirkham 82 W 11th Ave.

Two Story Frame Dwelling—Cost $3000. C. J. Killimede, owner. E 20th Ave 175 N Balboa.

Two Story Brick Store and Loft—Cost $4000. Chas. Wolf, Sr., owner. E 8th 220 S Howard.

One Story Frame Stores—Cost $23,000. O. H. Curtaz, owner. SE Golden Gate Ave and Leavenworth.

Two Story Frame Dwelling—Cost $3000. Annie M. Reed, owner. W 24th Ave 259 S Anza.

OCTOBER 28

One Story Steel Mill Factory—Cost $4000. Pacific Coast Glass Works, owner. SE Irwin and 7th.

OCTOBER 30

Two Story Frame Dwelling—Cost $3000. J. M. Peters, owner. W 12th Ave 125 S Cabrillo.

Store Alteration—Cost $6000. Pauson & Co., owner. NE Kearny and Sutter.

Two Story Frame Dwelling—Cost $3000. J. Welsh, owner. E 18th Ave 225 N Balboa.

Apartment Repairing—Cost $6000. Mrs. Jackson, owner. SE Eddy and Franklin.

Three Story Brick Furniture Store—Cost $74,000. I. I. and B. C. Brown, owners. SE Mission and 17th.

One Story Brick Market—Cost $3500. L. Hirsch, owner. W Mission 75 S 19th.

OCTOBER 31

Two Story Frame Apartments—Cost $9000. P. D. Tyler, owner. SW Lake and 9th Ave.

NOVEMBER 1

Three Story Frame Apartments—Cost $7000. P. Costello, owner. S Green 80 W Montgomery.

Two Story Frame Dwelling—Cost $5000. F. Nelson & Sons, owner. NE Portola Drive and 15th Ave.

Stores and Warehouse Alterations—Cost $15,000. Parrott Investment Co., owner. SW Davis and Sacramento.

One Story Frame Store and Flat—Cost $3000. V. Maita, owner. E Chenery 50 S Diamond.

Two Story Frame Dwelling—Cost $2900. Oscar Lind, owner. W 19th Ave 50 N Anza.

Two Story Frame Dwelling—Cost $2900. Oscar Lind, owner. W 19th Ave 75 N Anza.

Office Alterations—Cost $3000. National City Co., owner. 430 California.

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